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# Section I

# ENDOPROSTHESIS

# 1

# John Rhea Barton

FREDERICK R THOMPSON, M D *

I beg leave to call the attention of my professional brethren to the following paper believing that it contains some new views, in relation to a deformity and lameness, hitherto I think excluded from the surgeon's list of curable complaints, and one of the opprobria of our art I allude to a firm, bony anchylosis of the human joints.

BARTON

In these days of general orthopaedic interest in hip arthroplasty in which various types of endoprostheses are utilized it is interesting to review the work of Dr John Rhea Barton, of Philadelphia who in 1827 first stimulated our interest in this subject. Many have not had the opportunity of reading Barton's original paper entitled *On the Treatment of Anchylosis by the Formation of Artificial Joints* It had a far reaching effect on the surgical concept of the treatment of stiff joints by his confreres representing the new American School of Surgery in post Revolutionary times and was quoted widely in Europe

Barton then 32 years of age was a young attending surgeon on the staff of the Pennsylvania Hospital in Philadelphia He had seen in the hospital a sailor named John Coyle who had fallen from the ship's hatchway into the hold a year previously and sustained some type of fracture of the hip The hip was ankylosed in an adducted position with about 50° of flexion. Due to the lack of roentgenograms in those days opinion varied as to the real nature of the primary injury sustained. Some surgeons considered it to be due to a dislocation others to a fracture There was a history of prolonged inflammatory reaction in the hip following the injury so that the patient had lain in bed for 5 months with his thigh drawn up to a right angle Barton described his careful examination of the joint and ruled out dislocation because of the relative positions of the greater trochanter to the anterosuperior spine He felt that there had been an extensive comminuted fracture with disorganization of the joint, followed by subsequent inflammation, and that later true bony ankylosis had taken place The patient was placed in traction for several weeks to determine whether the ankylosis was fibrous or bony but the joint failed to change its position At about this time the patient fell under the

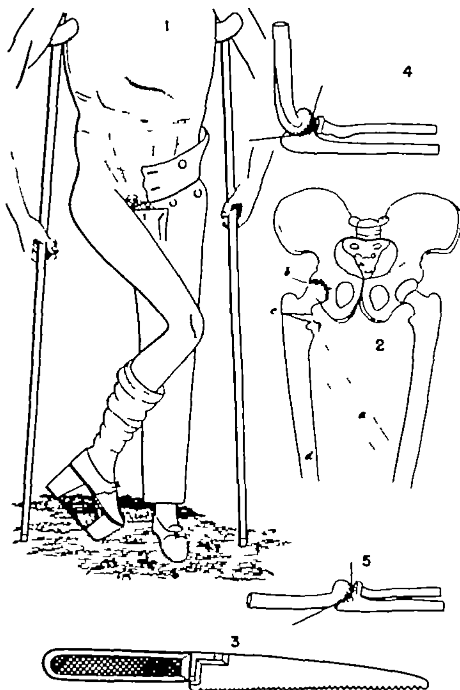


John Rhea Barton

* New York, N Y

care of other colleagues and Barton did not see Coyle again until a year later, when, finding him still in the hospital, he began to think about an operation that would correct the patient s severe adduction flexion in ternal rotation deformity and also give him active motion of the joint Essentially he planned to perform a subtrochanteric oste otomy and, after the "irritation" had passed away prevent the formation of bony union by gentle and daily movements of the limb Since his reasoning is interesting in view of our later knowledge of histology and sur gery I quote extensively from his article

In this proposition four material points pre sented themselves for consideration viz., the practicability of the operation the degree of risk to life consequent thereto the probability of being able to arrest ossific re union and the reasonable prospect of benefiting the patient thereby The arguments I adduced in favour of such an operation were these That the anatomy



of the part did not present any insurmountable obstacle to it The fear of cutting into a joint was not to be entertained here since from previous disease all the characteristics of a joint were gone synovial membrane destroyed cartilages absorbed *and an amalgamation* of the head of the femur with the acetabulum had taken place That the shock to the vital system would not probably be greater than is frequently endured from accidental injuries and other operations That if the opinion commonly assigned as the cause of the formation of false joints, after fractures be true such as frequent motion in the broken ends of the bone a deficiency of tone in the system etc these agents could be resorted to with promising results.

In order to decide the important question as to the benefit which the patient might reasonably be expected to derive from such an operation it was necessary to consider how nearly a joint, thus artificially formed would resemble in its construction and functions the natural articulation. What change the divided ends of the bone *would undergo whence would be derived its* cartilaginous surfaces, its ligaments its capsule and its synovia and, finally what was to restrain its undue motions. My hopes of improving his condition, were founded upon the following facts and observations in relation to these points. That a bone once divided, in a person otherwise healthy must again unite either by bone or by *ligament no case to my knowledge, being on* record where a broken bone remained always afterward destitute of attachment between the divided extremities except in cases where one of the fragments has been so small or so scantily supplied with blood, as to be unable to contribute its part in the restorative process being sufficiently vascular only to retain its own vitality as in case of the separation of the head of a bone If therefore, ossific union should be arrested ligamentous adhesions would maintain the connexion. Writers observe and it is confirmed by my own experience that when a fracture does not become consolidated in the course of time the rugged edges are removed by absorption the separated ends become condensed, smooth and polished, and tipped with a kind of cartilaginous substance they are likewise inclosed within a sort of capsule Observation has also proved to me, that this ligamentum structure formed around and connecting the ends of an old fracture, is possessed of great strength so much so that I have in several instances witnessed persons sustaining the entire weight of their bodies on the ligaments of a false joint, requiring only lateral support to the limb The freedom and latitude of motion, in such cases, and total insensibility to pain after a sufficient lapse of time I had also witnessed and [they] were encouraging arguments In the operation here proposed no such great strength of ligaments as will support the body would be required since from the *transverse* section of the trochanter bone will rest against bone and strength in them only to prevent dislocation would be necessary From my inquiries into the manner in which this joint was to be lubricated I did not expect that a synovial membrane and fluis, in all their characters, would be generated but ample proofs were not wanting of the immediate resources of nature in defending parts from injurious friction in whatever part of the body it might be required either by an exhalation from the adjacent structure or by the intervention of a bursa In the common false joint where motion is discouraged as much as possible sufficient moisture is there exuded to prevent painful attrition It might reasonably be expected, therefore, that where motion was continual the lubricating moisture would be more abundantly exhaled In un-united frac*tures, the false joint is uncontrollable because* there are no muscles specially adapted for its restraint but in the joint thus to be formed, *the will* alone must influence the movements since nearly all of the muscles which exercised their control over the original joint would be carefully preserved to have a similar power over this which is in fact a mere transfer of the *point of articulation and resistance from the* head of the bone in the acetabulum, to the upper end of the shaft of the femur against the great trochanter

Although I did not think it essential to the melioration of my patient s condition that the ends of the bone should at its section undergo any change further than by absorption of the asperities, I did believe that nature would not passively witness my labours to effect what she has so often herself endeavoured, unaided by art, to accomplish, but that she would be ready to co-operate with me, and to extend to completion that which human art alone would be incapable of—the formation of a new and useful joint as a substitute for that which disease had annihilated, either by the conversion of the trochanter into a socket, or by some more wise design.

These views were fully explained to my colleagues, and were accompanied by the assurance, that my patient had been fairly appraised of his present condition and of the nature and intentions of the operation proposed that he had not merely acceded to it, but that, after placing the sufferings, the difficulties, the risks to life the chances of failure, and the dangers

eventually of aggravated lameness in the strongest and most exaggerated light, he had expressed his willingness to endure any pain or duration of suffering and to subject himself to all hazards, for the remotest prospect of relief

Accordingly on the 22nd day of November 1827 assisted by Doctors Hewson and Parrish, I proceeded to the operation publicly in the Pennsylvania Hospital.

The integuments and fascia being divided and raised, the muscles in contact with the bone around part of the great trochanter were carefully detached and a passage thereby made just large enough to admit of the insinuation of my fore-fingers, before and behind the bone the tips of which now met around the lower part of the cervix of the femur a little above its root. The saw (Fig 3) was readily applied, and, without any difficulty a separation of the bone was effected. The thigh was not released and I immediately turned out the knee extended the leg and placed the limbs side by side by a comparison of which in reference to length, the unsound member betrayed a shortening of about half an inch This might have been caused partly by a distortion of the pelvis. Not one blood vessel required to be secured. Union by the first intention was not attempted the lips of the wound were only supported by adhesive plaster and slight dressings. The patient was put to bed and Desault s splints were applied to support the limb

The operation though severe was not of long duration, it being accomplished in the space of about 7 minutes.

Barton dressed the wound daily and noticed the anticipated secretion of pus on the sixth day and the appearance of healthy granulations on the eleventh day Beginning on the twentieth day after operation, and while the wound still was granulating and draining, the limb was moved cautiously by Barton in each direction to resemble the natural movement of a sound hip joint. In doing this he was careful never to use violence or to continue it or repeat it so often as to occasion any permanent irritation. A sufficient time always was allowed for the patient to recover from the soreness of the last motions before the limb was disturbed again At first it was necessary to allow an interval of several days between the movements in order to obtain a subsidence of the soreness However in the course of a short time as the part became more insensible to pain from this disturbance the limb was moved more frequently Active motions of the hip were encouraged at about the sixth week. On the patient s sixtieth day the wound, having healed entirely and all appearances of inflammation having gone Coyle was assisted carefully from his bed and, aided by crutches, stood erect with both feet reaching the floor Coyle estimated that he bore 10 or 12 pounds of weight on the weakened limb for a few minutes. He was able to advance the leg actively and to rotate it slightly without pain. The following day the limb felt a little sore and some fluctuation was discovered anteriorly which, the next day drained a quantity of fluid

At his eighth week

the patient, in the presence of the medical class of the hospital, walked around the room several times, then held out his crutches, showing he was capable of sustaining much of the weight of his body on the limb without pain On being asked whether he felt as if he had, at the hip solid support for his body he answered in the affirmative.

The following month Coyle developed an attack of erysipelas with abscess formation in the previously healed sinus This cleared up within a few days and did not cause any pain on movement of the joint there nor did it seem to impede the movement of the joint.

By the end of the third month Barton noted

he arises in the morning and retires not until night in the meantime amusing himself by exercise in walking, which he now begins to accomplish by the aid merely of a cane Time only seems to be required to enable him to walk without even this assistance The following is the degree to which he can perform the movements of his limb with perfect ease By measurement from a straight line, he can advance the foot 24 inches in stepping backward 26 inches in abduction 20 inches in rotation inward, 6 inches and outward, 6 inches. By the fourth month the patient was able to walk a short distance without the aid of a cane and continued to improve from that point onward

In concluding his paper Barton stated

Having now established the fact that an artificial joint can be substituted for the loss of a natural articulation at the hip it becomes a

matter of importance to ascertain how far the same principles are applicable to the formation of new joints in other parts of the body where natural motion has been lost My reflections on this point have not presented any forbidding circumstances but it is not in every joint that the loss of motion would be sufficiently important to call for the aid of a painful operation The most serious evil is sustained by the loss of the hip knee shoulder elbow great toe and finger joints and of the lower jaw These, I believe may all come within the reach of amendment by an operation, if the muscles which move these respective joints are in a sound and effective state. If they have been lost, it would be probably wrong to form a joint since its unrestrained motion would be more troublesome than a rigid limb A transverse section of the bone would be proper if the operation were to be attempted at the shoulder knee fingers, or toes, but an angular division would be necessary at the elbow in order to preserve some resemblance to the natural point at this part I have therefore given in the plate, a sketch of an anchylosed elbow in the straight and angular position and the manner in which the section would be most advantageously made.

Coyle enjoyed the use of his artificial joint for 6 years during which time he worked as a trunk maker In a subsequent paper *On a New Treatment for Certain Cases of Anchylosis* Barton gave a follow up on Coyle

The patient upon whom this operation was performed enjoyed the use of his artificial joint for six years, during which period he pursued a business (trunk making) with great industry earning for himself a comfortable sustenance and a small annual surplus. Pecuniary losses, however through the reverses of those in whose hands he had confided his means sunk him into a state of despondency and desperation, followed by habits of intemperance Thus, with all the train of evils, abuse of health, etc was no doubt the cause of the change which afterward took place in the artificial joint. It gradually became more and more rigid and finally all motion ceased in the part. With this exception the benefits of my operation were retained and fully appreciated until the period of his death for as the limb had been freed from deformity and restored to a useful position he had no occasion, even for a cane to aid in walking During an attack of Asiatic cholera he expressed a desire that I should be sent for in order that he might renew his bequest to me of the parts interested in the operation. He, recovered from the cholera, but subsequently died of phthisis pulmonaris The autopsy exhibited the parts as described in the published case with the artificial joint anchylosed a change which had been effected within the two years previous to his death With ordinary care in all probability this would not have taken place

The final history of this case presents now the important fact that benefit had resulted which fully requited the individual for the pains he had endured and were considered by him even after the closure of the joint, yet an ample reward for the operation he had undergone

John Rhea Barton, the son of Judge William Barton, was born in Lancaster Pa in April, 1794 His grandmother was the sister of the well known astronomer David Rittenhouse an uncle was the early naturalist and antiquarian Benjamin Smith Barton John Rhea Barton served his apprenticeship in medicine in the Pennsylvania Hospital taking his medical degree in 1818 He worked under the celebrated Philadelphia physicians Philip Syng Physick (who treated bone nonunions by the seton) Dorsey and Hewson In 1823, when he was 29 years of age he was appointed to the surgical staff of the Pennsylvania Hospital. He showed unusual manual skill and ingenuity which directed his endeavors toward the treatment of fractures In operating, he was ambidextrous and rarely changed his position at the operating table He is credited with devising the figure-of-eight bandage for the head and thus dispensing with the clumsy devices then in vogue in dealing with fractures of the lower jaw He introduced bran dressings in the treatment of compound fractures which as his biographer Kelly states actually were an excellent breeding place for myriads of bedbugs His careful, precise observations led him to describe a rare type of subluxation of the carpus that was associated with a fracture of the articular rim of the radius which to this day is known as a Barton's fracture of the wrist. In the absence of roentgenographic confirmation it is astonishing that he could separate this entity out of the large group of Colles fractures presenting themselves to him for treatment. His three most noteworthy surgical contributions to the literature are the paper described

above, his *Longitudinal Section of the Lower Jaw for the Removal of a Tumor* and his *New Treatment for Certain Cases of Anchylosis* in which he presented the principle of a wedge osteotomy at the knee for the correction of a right angle bony ankylosis of the knee He wired a fractured patella as early as 1854 and, although his patient died of postoperative suppuration, Barton believed that he had established a new principle in the treatment of these injuries.

Born of distinguished forebears and educated under the tutelage of great teachers of his day his ingenuity and incentive were stimulated to place him in the forefront of that group of early American surgeons forming the vanguard of the new American School of Surgery As Oliver Wendell Holmes said, Genius comes in clusters and shines rarely as a single star " Personally he possessed an easy dignity of manner a cheerful disposition and a heart full of human kindness. His quality of personal magnetism was noted particularly as he made rounds in the hospital he spoke words of encouragement to each bed inmate and left sympathy and comfort in his wake Agnew said of him

> With all his other qualities of head and heart, Barton was a man of great simplicity of life and entirely free of all appearance of ostentation or display He moved quietly among his fellow townsmen without drumbeat or flaunting banners I remember well his equipage Not a showy phaeton drawn by fiery steeds whose pedigree might be traced to the stalls of Solomon, no buttons, no tigers, no obsequious lackeys to herald the presence of the man but a plain substantial horse and buggy driven by those hands whose cunning had wrought so many marvels of surgical skill

His first wife died later he remarried

Although the *Dictionary of American Biography* states that he retired from active practice in 1840 his obituary in the *Lancaster Intelligencer* of 1871 states that in the steady pursuit of his profession for 30 years he acquired an ample fortune which was increased largely by his marriage to the daughter of Mr Jacob Ridgway At any rate it is difficult to unearth further biographical material of this distinguished man who in the first 17 years of his practice was responsible for several important landmarks in surgery In his later years his practice was chiefly a consultative one his advice was solicited by both physician and patient when difficult surgery was contemplated

Upon his death in his seventy-seventh year his wife bequeathed $50 000 to the University of Pennsylvania to endow a Chair of Surgery the incumbent of the Chair to be designated as the John Rhea Barton Professor of Surgery The distinguished surgeon I S Ravdin now occupies that Chair

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# 2

# Indications and Contraindications for the Early Use of an Intramedullary Hip Prosthesis

FREDERICK R THOMPSON M D *

In discussing the indications and the contraindications for the early use of an intramedullary hip prosthesis one must keep in mind 3 salient facts

1 A well healed and well nailed fracture of the femoral neck that has not developed circulatory changes is better than any type of hip prosthesis Such a femoral head is alive and with normal metabolism it should serve the individual until his death Ultimate breakage of any prosthesis is possible

2. An arthritic or aseptic necrotic head of the femur in a young adult wage earner has no better therapy to provide long hours of hard work without pain or fatigue than an arthrodesis of the hip

3 The prime indication for the use of an artificial hip of any type is as a salvage procedure (Fig. 6)

If these sound orthopaedic dicta are kept in the forefront of the surgeon s mind in forming surgical judgments there will be found justifiable indications and special situations that call for the early use of an intramedullary hip prosthesis

In general the intramedullary type of hip prosthesis can be used in all instances in which the Judet, or femoral neck type can be used The early reluctance of some to cut away a seemingly healthy neck of femur has disappeared, in view of the mechanical stress advantages to be gained from this type as opposed to the Judet type Either type will work satisfactorily if it is inserted under the proper conditions and indications, but there is less chance of subsequent trouble if the intramedullary type is used standardly

The most common abuse of the use of endoprostheses is in fresh fractures of the femoral neck One s surgical judgment may be influenced more by fascination for the new surgical tool than by the sound orthopaedic dicta mentioned above More often it is a case of one s surgical judgment being influenced by the immediate advantages, economically and functionally to be obtained from an artificial hip rather than the long term advantages of a more costly longer convalescent procedure of primary hip nailing. Often the surgical judgment of the surgeon is based on his own particular experience with the type of fracture involved rather than on the over all picture of what is to be expected with that especial fracture throughout the land. Common instances of the improper use in fresh fractures of the endoprosthesis are in (1) the high head fracture (2) the aged and (3) the Pauwels Type 3 fracture

**The High Head Fracture.** In those high fractures of the femoral neck in which the break has occurred close to the head itself and has left only a small bony fragment to be engaged by the Smith-Petersen nail, some surgeons believe that an endoprosthesis is indicated because the head fragment is dead and will not unite (Fig. 1) The bone in these small head fragments is no more dead than in fractures that occur at farther distances down the femoral neck. It is dif

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FIG 1 A high head fracture 7 years after nailing with "telescoping healing" that resulted in a short neck but a viable head.

ficult to find any convincing evidence that a femoral head is alive after the neck has been fractured Regardless of the fact that the head is dead there is no doubt that the live neck does unite to the dead head. Proper revascularization takes place during the ensuing months after the head has been immobilized adequately by the nail and ultimately a viable or living, head is secured This process takes a considerable length of time probably close to 9 months. It may occur earlier with proper immobilization of the fracture site and without the detrimental effect of early weight-bearing. Inadequate immobilization, inadequate circulation and other causes seem to produce absorption of portion of the femoral neck during the so-called telescopic healing of the fracture site (Fig. 1) However a living, viable head, whether obtained in a few months or after 9 months gives an excellent hip without pain or limp and with perfect stability Small head fragments are infrequent, and every attempt should be made to secure bony union by the standard nailing procedure The prosthesis should be saved for the exceptional case in which other special factors justify the use of the less efficient metal head affording early ambulation If the fracture should fail to heal or if aseptic necrosis should develop after healing, then the salvage possibilities of a prosthesis are justifiable

Special factors become more clear cut when seen in their proper relationship to the known over all picture of displaced fractures of the neck of the femur Cleveland has shown that in these displaced fractures there will be at least a 20 per cent incidence of nonunion of the nailed fracture Of those fractures that go on to union another 22 per cent will develop aseptic necrosis. These figures do not apply to undisplaced fractures in which the results are much better In the displaced fractures therefore the over all picture is rather grim with its 58 per cent excellent results On the bright side of the picture however Cleveland has shown that about half the patients labeled aseptic necrosis have no pain and consider the results excellent, in spite of the poor rating given them by the doctor Therefore from a clinical evaluation alone the results can be considered good in roughly two thirds of the nailed fractured necks of the femur

The Aged A real controversy exists over early use of the endoprosthesis in the aged When the over all results of hip fractures, as mentioned above are balanced against the prolonged convalescence and the cost of a standard hip nailing in this group many special factors justify the use of the endoprosthesis. Age however is relative Bony union has been achieved in the tenth decade in fractured femoral necks with the patient able to walk without pain with the aid of a cane in 9 months as well as or better than would have been possible with the primary use of an endoprosthesis A primary nailing holds less morbidity in the hands of most surgeons than the surgery necessary for a prosthesis therefore age is not necessarily a primary indication for its use Special factors are present in some cases and may justify its being employed

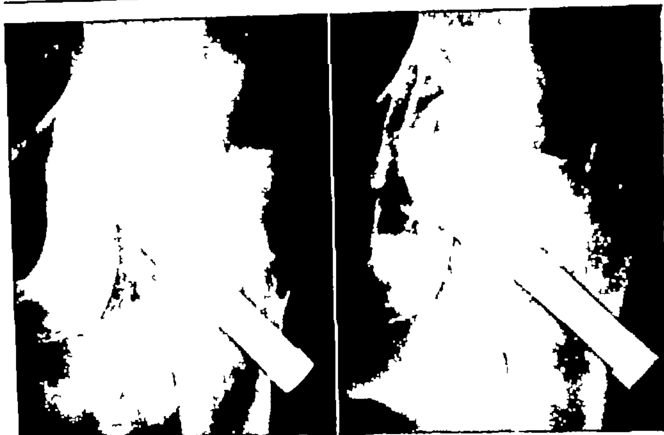


FIG. 2. A Pauwels Type 3 fracture It is not an indication for a primary endoprosthesis.

**The Pauwels Type 3 Fracture.** In the vertical fracture of the femoral neck (Fig. 2) known to most as the Pauwels Type 3 fracture there has been the impression that nonunion usually results In the series reported by Cleveland, this has not been found to be true his cases united. The majority of nonunions occurred in fractures of the so-called easier type It is believed therefore that in such vertical fractures a primary nailing should be attempted If union fails to occur an endoprosthesis then should be employed.

## TECHNICAL SURGICAL DIFFICULTIES

Technical surgical difficulties may arise at the time of operation in attempting to reduce and nail the fractured neck of the femur This has caused some surgeons to abandon the intended nailing procedure and to use a prosthesis instead.

**Inadequate Reductions.** Such a primary difficulty is the inability adequately to reduce the head on the neck In the past, this usually has been handled by resorting to an open reduction and attempting, by direct visualization to reposition the head properly on top of the fractured neck The uninitiated should be warned that an open reduction rarely achieves a better reduction than a closed one In the experience of most surgeons an open reduction leads to more nonunions than a closed reduction Since many an inadequate reduction goes on to satisfactory union of the fragments it seems wiser to attempt to nail the inadequately reduced head and save the endoprosthesis as a secondary procedure when either nonunion or further slipping occurs However here, too there undoubtedly will be special instances in which the endoprosthesis is advisable at the primary operation, after all other factors have been considered.

**End to-Side Nailing** Another technical difficulty encountered by the surgeon in the obese is the failure to obtain adequate roent-



FIG. 1 A high head fracture 7 years after nailing with "telescoping healing" that resulted in a short neck but a viable head.

ficult to find any convincing evidence that a femoral head is alive after the neck has been fractured. Regardless of the fact that the head is dead, there is no doubt that the live neck does unite to the dead head Proper revascularization takes place during the ensuing months after the head has been immobilized adequately by the nail, and ultimately a viable or living, head is secured. This process takes a considerable length of time probably close to 9 months. It may occur earlier with proper immobilization of the fracture site and without the detrimental effect of early weight-bearing Inadequate immobilization inadequate circulation and other causes seem to produce absorption of a portion of the femoral neck during the so-called telescopic healing of the fracture site (Fig 1) However a living, viable head, whether obtained in a few months or after 9 months gives an excellent hip without pain or limp and with perfect stability Small head fragments are infrequent, and every attempt should be made to secure bony union by the standard nailing procedure The prosthesis should be saved for the exceptional case in which other special factors justify the use of the less efficient metal head affording early ambulation If the fracture should fail to heal, or if aseptic necrosis should develop after healing, then the salvage possibilities of a prosthesis are justifiable

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## TECHNICAL SURGICAL DIFFICULTIES

Technical surgical difficulties may arise at the time of operation in attempting to reduce and nail the fractured neck of the femur This has caused some surgeons to abandon the intended nailing procedure and to use a prosthesis instead.

**Inadequate Reductions.** Such a primary difficulty is the inability adequately to reduce the head on the neck In the past, this usually has been handled by resorting to an open reduction and attempting, by direct visualization to reposition the head properly on top of the fractured neck. The uninitiated should be warned that an open reduction rarely achieves a better reduction than a closed one In the experience of most surgeons an open reduction leads to more nonunions than a closed reduction Since many an inadequate reduction goes on to satisfactory union of the fragments it seems wiser to attempt to nail the inadequately reduced head and save the endoprosthesis as a secondary procedure when either nonunion or further slipping occurs However here too there undoubtedly will be special instances in which the endoprosthesis is advisable at the primary operation, after all other factors have been considered.

**End-to-Side Nailing** Another technical difficulty encountered by the surgeon in the obese is the failure to obtain adequate roent-



FIG. 3 Example of end-to-side nailing of fracture If such fractures heal, aseptic necrosis develops inevitably A prosthesis is indicated here

gen views of the position of the femoral head at the time of operation. This results occa sionally in the nailing of the head in a side wise *position against the fractured surface* of the neck (Fig 3) Usually it is noted when a so-called frog-lateral view is taken at the conclusion of surgery The nail usually is seen to have penetrated the superior neck surface of the head fragment, and the jagged fracture line of the head fragment is seen projecting inferiorly and distally Although union generally is reported in such instances, aseptic necrosis develops inevitably Here an endoprosthesis is indicated, although usually *it is saved as a secondary procedure of sal* vage due to the fact that it is rarely recognized until the termination of a major oper ation

Split Head Fragments Some femoral heads have a fragment split off their superior portion during the technic of nailing When this weight bearing portion of the head is torn loose from the parent fragment, a prosthesis is believed to be indicated as an immediate procedure

*Soft Head. Occasionally a femoral head* is so soft (Fig. 4) at the time of primary nailing that, with his fingers the surgeon can push the Smith-Petersen nail inward its full length toward the dome of the head These decalcified bones offer no support for a Smith-Petersen nail a Jewett nail or any other internal appliance An abduction osteotomy is of little help in solving this problem unless one is prepared to use plaster spica support in addition. Within a few weeks the *nail* backs out of the soft head and the femoral head slips off the neck This is a justifiable indication for the primary use of an endoprosthesis.

## SPECIAL INSTANCES SERVING AS INDICATIONS

The immediate use of the prosthesis is indicated in the following special instances in fractured neck of the femur (1) fracture in an aseptic necrotic head (2) radium necrosis

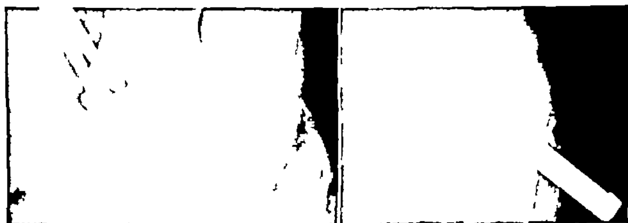


FIG. 4 Demineralized bone in which the nail holds no purchase A prosthesis is indicated here.

fractures (3) rheumatoid arthritis, (4) bed ridden patients (5) metastatic malignancy and (6) shock therapy fractures

Fracture of the femoral neck secondary to aseptic necrosis of the head of the femur is a definite indication for the primary use of the endoprosthesis In these cases the death of the bone occurs well down in the femoral neck close to the intertrochanteric line (Fig. 5) The prosthetic head of the Judet type is inadvisable The important decision to be made is whether the hip should be arthrodesed if a patient is an adult wage earner or whether a prosthesis may be employed if the patient is older In young people the aseptic necrosis is more apt to be due to caisson disease or to be secondary to dislocated hips In these the acetabulum rarely is altered, and usually it is not necessary to perform a reaming-out of the acetabulum to socket the artificial metal head firmly In older people, however, in whom aseptic necrosis has developed after a healed fractured neck of the femur (Fig. 6) the head slowly becomes deformed from minute wedge-shaped fractures, and the acetabulum likewise undergoes mirror image changes in contour When the endoprosthesis is inserted, it is nearly always necessary to ream out a proper socket in the acetabulum This



Fig 5 Fracture in an aseptic necrotic head due to dislocation of the hip A prime indication for early use of an endoprosthesis

is a major formidable procedure in the aged.

Radium necrosis fractures of the femoral neck sometimes are seen after the use of extensive radium therapy for carcinoma of the cervix Copeland has shown that death of bone occurs throughout the head and the neck of some of these femurs, and occasionally the bone death occurs well down into the femoral shaft. It is difficult to understand how these fractures can heal



Fig. 6 (*Left*) Aseptic necrosis due to healed neck fracture (*Right*) Prime use of an endoprosthesis



FIG 7 (*Left*) Metastatic carcinoma from breast with femoral neck fracture. (*Right*) Undisplaced fracture healed by bed rest in case of metastatic malignancy

since the neck side of the fracture is as dead as the fractured head itself. Sections of bone taken from one of our cases confirm Copeland s findings of the existence of dead bone at the base of the femoral neck. In these instances it is justifiable to insert an endoprosthesis as a primary procedure However, one must not forget that there are instances of so-called pathologic fracture of the neck of the femur after radiation therapy that have healed by primary nailing. When after considering all the factors involved, one believes that the particular patient will live a long time a primary nailing of the fractured head may be indicated If however the life span is prejudiced strongly one is justified in the early use of the prosthesis

Rheumatoid arthritis of the chronic multiple type represents another instance in which specific factors justify the early use of the prosthesis When fractured neck of the femur occurs in these cases primary nailing usually has not been satisfactory The early use of the prosthesis allows early ambulation and in our few cases it has permitted more motion as a final result than the patient had prior to the fracture The hip is singularly more comfortable than before the accident. However one must not forget that the use of a prosthesis in most rheumatoid patients places the operation more in the category of doing an optional arthroplasty for relief of pain.

Permanently bedridden patients are in less danger from a primary nailing than from the operation to excise the head or to insert the endoprosthesis as a primary procedure There are many instances in terminal nursing care in which the early use of the endoprosthesis is indicated Such an instance is the hypertensive hemiplegic male with a strongly prejudiced life span who because of bladder difficulties is encouraged for better health to make use of a wheel chair and occasionally be ambulatory In these cases it certainly seems better to use the endoprosthesis than to excise the fractured femoral head. The primary use of an endoprosthesis allows these patients within a few days to resume their limited degree of activity for the remaining months of their lives.

In metastatic malignancies with fractured femoral necks when one has considered all the factors involved and believes that the particular patient will live a long time a primary nailing of the fractured head usually is indicated. An anticipated short life span may justify the early use of the prosthesis If the patient is bedridden and in a terminal phase some prefer to excise the femoral head for comfort. Since many of these patients live longer than is calculated,

it is better to insert a prosthesis for hip sta bility, as many may walk again In the light of future developments it must be realized that estimates of life span are sometimes ridiculous. In one instance a patient with carcinoma of the breast whose roentgenograms showed a fractured neck of the femur (Fig. 7) with mottling of the ilium as well as of the femoral shaft, the life expectancy was estimated at less than 4 months Treated without primary nailing and without prosthesis but by bed rest alone, the fracture went on to satisfactory union and after 4 years, the patient still is alive

In some patients with multiple myeloma with femoral neck fractures, the bone is so soft that it is impossible to obtain fixation by means of a Smith-Petersen nail In such cases the primary use of an endoprosthesis makes for humane terminal nursing care

Institutional mental cases sustaining femoral neck fractures in the course of shock therapy have been treated by a pri mary endoprosthesis. If in the opinion of the physician, the shock therapy should be continued without delay the primary endoprosthesis operation is justifiable A primary nailing procedure might cause a delay of 9 months in the shock therapy

## SUMMARY

1 The primary use of an intramedullary hip prosthesis is for salvage of those fractured necks of the femur that have devel oped nonunion or have gone on to aseptic necrosis after union

2 There are no absolute indications for the early use of the hip prosthesis but there are justifiable indications

3 Except in rare instances in which certain special factors are present, early use of the prosthesis is contraindicated in fresh fractures It is being grossly misused in fractures in the aged, in high subcapital fractures and in the high-angle Pauwels Type 3 fracture Usually it is contraindicated when the fracture cannot be reduced properly and one must settle for an imperfect nailing

4 The justifiable indications are

A Fracture occurring in an aseptic ne crotic head

B Radium necrosis fractures of the fem oral neck

C Those soft femoral heads in which from either demineralization or metastatic tumors internal fixation cannot be main tained with a Smith Petersen nail

D Rheumatoid arthritis fractures of the femoral neck

E. Certain cystic or malignant bone dis eases, as a humane adjunct to nursing care

F Certain shock therapy fractures in mental patients

## Indicationes e Contraindicationes pro le Uso Precoce de un Prosthese Coxal Intramedullar

*Summario in Interlingua*

Le indication primari pro le uso de un prosthese coxal intramedullar es le presentia de salvabile collos femoral fracturate le quales ha disveloppate nonunion o le quales monstra necrosis aseptic post union solide Il non existe ulle indicationes absolute pro le uso precoce de prostheses coxal, sed certe casos es characterisate per le presentia de factores specific que justifica su introduction. Prostheses es contraindicate in nove fracturas excepte in rarissime casos in que tal specific factores es presente Lor uso es un abuso in fracturas del collo femoral in subjectos de etate avantiate in fracturas del typo alte subcapital, e in fracturas a alte angulo del typo 3 de Pauwel. Lor uso es generalmente contraindicate in casos de fractura que non pote esser reducite adequate mente Illo es difinitemente indicate in nove fracturas quando le fragmento capital es si discalcificate que illo non supporta ulle typo de fixation interne

Indicationes justificabile pro le uso pre coce de prostheses es fracturas occurrente in un capite necrotic aseptic fracturas a necrosis de radium fracturas in casos de chronic mul

tiple arthritis rheumatoide, e certe fracturas occurrente in patientes psychiatric post thera pia a choc Prostheses es etiam justificabile como adjuncto humanitari al sollicitude general in certe cystic o maligne morbos ossee In omne caso on non debe unquam oblidar que ultimemente omne prosthese pote rum per se On debe cautemente ponderar omne altere factores que es possibilemente capace a resultar in un viabile e solide capite femoral ante que on prende recurso al uso de inerte metallo Inter patientes de etates plus ju vene arthrodese coxal remane le methodo de salvamento a seliger Illo permitte a juvene travaliatores retornar a longe horas de labor remunerative

# 3

# The Choice of Prosthetic Materials and Evaluation of Results

Duncan C McKeever M D, F A C S *

If a prosthesis fails because it is of incorrect mechanical design or is inserted improperly this does not condemn prostheses in principle It reflects on the knowledge, the skill and the judgment of the designer and the surgeon In this connection it must be remembered that the fact that a prosthesis works sometimes most of the time or even all of the time is no proof that it is correct mechanically or that it has been inserted properly

If a prosthesis is of proper design and is inserted properly in a patient having a negative metabolic balance it will fail for want of proper physiologic response to the presence of the prosthesis This cannot be used statistically to condemn prostheses in principle It exposes the limited vision of the surgeon who has treated the local defect without considering the metabolic status of the patient.

*The only significant results are the failures and the successes that occur when correctly engineered prostheses are inserted properly in patients with normal metabolism*

The body must react in some way to the prosthesis or indeed, to any foreign body If the prosthesis initiates no chemical or electrolytic reaction, it must limit healing by acting as a mechanical barrier modifying the layer of connective tissue cells in contact with it. In bone the body must bring about a revision of stress lines in relation to the prosthesis, particularly at the level of transfer of stress from the prosthesis to the bone

* Houston Texas.

Medical control of the patient s physiologic processes is of paramount importance and the patient must be in a state of positive metabolic balance in order to react in a positive manner to the presence of the prosthesis This presupposes adequate diet normal digestion and physiologic hormone and vitamin levels, in other words, a healthy individual capable of completing the anabolic processes related to healing. If the body fails to react in this way, the prosthesis will fail in some degree.

Mechanical modification of physiologic response is controllable through proper functional mechanical design and proper surgical technic Conception of a design or evaluation of it requires a careful consideration of functional anatomy basic engineering principles and physiologic responses. The concept must bridge the gap between these elements and foresee their effect on each other and the effect of the combination of them on the end result.

The choice of suitable material for a specific prosthesis may depend on physical or chemical properties of the substance the design of the prosthesis problems related to its fabrication or any combination of these factors

It is axiomatic that prosthetic material for use within the body must be inert. However the term *inert* as applied to such materials is a relative one Few if any substances are totally inert under all physical and chemical conditions encountered in the body Some



FIG. 1 Nylon prosthesis after 2 years in a case of malum coxae senilis It was always painful. The patient never bore full weight for more than a few steps.



FIG. 2. Powdered nylon and fibrous tissue removed from patient in Figure 1

of the plastic materials that approach most nearly the state of being completely inert have other physical properties that make them unsuitable or undesirable for use in prostheses Such a substance is the plastic known as teflon. The pure plastic teflon apparently is completely inert for all prac tical purposes at least, it meets the most rigid test that can be applied to any substance that of showing no reaction when placed as a ground powder within the abdominal cavity of an experimental animal. However teflon is not resistant to abrasion and is not completely rigid This makes it suitable for some purposes in industry such as oil-less bearings but it limits its use within the body

Nylon and acrylic plastics of several formulas have been used in making prostheses of various kinds particularly hip prostheses. These plastics, indeed all plastics, are of varied chemical formula even within one trade name such as nylon The basic nylon plastic may have many different organic and inorganic substances added to it in order to modify its physical and chemical properties and these may be less inert than the basic plastic Some of them may be highly irritating in tissue It is possible that some of them are carcinogenic Both nylon and acrylic plastics are extremely hard and resistant to blows, but they are not resistant to abrasion, and they are subject to breakage incident to the application of repeated stress

Nylon in particular has been affected very adversely by abrasion, especially in hip prostheses in which the opposing surface of the acetabulum was definitely roughened. After a few months of abrasion against a rough surface of eburnated bone the head of a hip prosthesis may be worn away almost completely or ground to a powder. (Fig. 1) When this grinding-up of a substance into a powder takes place the term *relatively inert* takes on a new meaning The reaction of the body to the presence of a foreign substance is in direct proportion to the surface area exposed to the body tissues and fluids For purposes of illustration a 1 inch cube of nylon has a surface area of 6 square inches. If this cube is cut into eight ½ inch cubes, the surface area is 12 square inches By direct mathematical progression, the surface area on ¼ inch cubes is 24 square inches and when the size of the cubes reaches 1/1 000 of an inch, the surface area exposed to the body tissues is approximately 31 square feet. The reaction of the body to this enormous surface area of nylon within it is violent (Fig. 2) There is a marked production of exudate and of fibrous tissue with

a lytic reaction on local bone, so that the acetabulum may seem to melt away, and as the prosthesis grows smaller through abrasion, the acetabulum grows larger due to absorption This is aggravated secondarily by the abnormal motion of the abraided and uneven surface of the head within the acetabular cavity If the head is opposed to a normal acetabulum this abrasion takes place slowly, if at all but wear between the stem and the neck of the femur may occur (Fig 3) Similar reactions occur in the presence of the various acrylic plastics and this type of plastic also is subject to fragmentation

These physical properties limit the usefulness of acrylic and nylon, and the only feasible use of nylon within the body is as a temporary interposition membrane in locations in which it is not subject to mechanical abrasion. Even in these locations it may be somewhat irritating at times if a fairly large surface area is present.

Titanium metal in a pure or nearly pure form is relatively inert, though a great many modifying alloys and other substances often are added to it to alter its physical properties and here again the name *titanium* does not necessarily specify the pure metal While the pure metal may be inert, many of its commercial forms are not inert. Titanium has the dubious advantage of being lighter than stainless steel or Vitallium In most locations, differences in weight between different prosthetic materials are of no significance whatever and, since the weight is placed at the fulcrum of motion, it makes no practical difference whether a hip prosthesis weighs 1 ounce or 1 pound, or even more than a pound Since two metallic substances of fairly known and stable properties have been in use in orthopaedic surgery for prosthetic purposes for a number of years and have been found to be satisfactory some other factor than the difference in weight will have to be found to justify the adoption of titanium for this purpose The various stainless steels that have been found to be suitable for plates, screws and prosthetic devices are of fairly well known and standard composition Vitallium, a mixture of cobalt, chromium and molybdenum, has been used within the body for over 20 years and is known to be inert for all practical purposes Both stainless steel and Vitallium are highly desirable for insertion within the body from the standpoint of their physical and chemical properties and the choice between them must be made on some basis other than a comparison of their reactions within the body Such distinctions can be made on the basis of their physical properties as they relate to design and fabrication Stainless steel has much greater resistance to repeated bending stress, and, within certain limits, it has a definite springlike action that is not possessed by Vitallium. Therefore it is bet

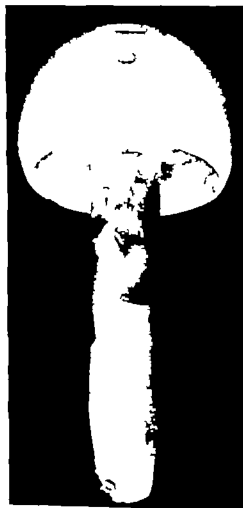


Fig 3 Abrasion of nylon stem after 2 years use in a patient with a smooth acetabulum.

ter that those prostheses that may be subjected to such stresses be made of stainless steel It has a further advantage in that it can be machined.

Some prostheses are of such complicated shape and design that machining is difficult or impossible Such designs can be cast much more easily than they can be made of stainless steel, and for them Vitallium would seem to be much more suitable The recent developments and improvements in casting processes have made the casting of larger prosthetic devices more satisfactory than has been the case in the past, and it is possible now to cast fairly large prostheses without intrinsic defects incident to the casting process The presence of defects in critical locations can be detected by means of x ray, and prostheses containing such defects can be rejected

Care must be used in processing metals, because certain manufacturing procedures may alter radically the physical and the chemical properties of the metal and make it highly irritating within the tissue This is true of stainless steel. Heat alone may modify its properties significantly Abrasives and buffing compounds used in giving stainless steel a high polish may flow into the surface of the metal and produce severe irritation when they are placed within the body The use of chemicals to remove such embedded and included abrasives is not completely satisfactory as it removes some of the surface of the metal and precludes the attainment of a very high polish. Electrolytic polishing gives a better surface Further development of polishing methods for use on stainless-steel surfaces is desirable and no doubt such methods will be found—or they may have been found already—and applied in some other field from which they can be adapted for use in the manufacture of endoprostheses

## SUMMARY

Basic dicta for use in evaluating results in endoprosthetic surgery are proposed.

Reasons have been set forth that seem to show that acrylic plastics and nylon are not suitable substances for the manufacture of endoprostheses. Stainless steel and Vitallium have proven to be suitable substances, and one or the other can be used for almost any conceivable rigid prosthesis The relative weight of various substances used for the construction of prostheses is of no practical significance if the weight is located at or near a fulcrum round which joint motion takes place

## Le Selection de Materiales Prosthetic e Evalutation del Resultatos

*Summario in Interlingua*

Le selection de un o le altere material pro prostheses depende de su qualificationes physic e chimic del typo de construction a usar e del difficultates de fabrication a expectar Le material debe esser relativemente inerte in le corpore Il occurre que un certe material possede un o duo favorabile qualitates durante que alteres inter su qualitates rende impossibile su uso pro un specific typo de construction prosthetic Teflon, nylon e omne plasticos acrylic e le plasticos modulate per polymerisation ha varie formulas chimic Illos non resiste ben a effectos abrasive A vices substantias chimic ha essite addite a illos pro modificar lor qualitates physic e il es possibile que tal substantias rende los inutilisabile pro prostheses Alicunes de iste materiales es multo irritante pro le textos del corpore Il es possibile que alicunes es carcinogene

Nylon es firme e facile a modular sed illo non resiste a abrasion e es certo non usabile in prostheses coxal

In le caso de materiales que causa un multo leve reaction intra le corpore ille reaction es proportional al superficie total del material in question Un centimetro cubic de nylon ha un superficie de 6 centimetros quadrate Si iste pecia de nylon es molite usque le resultante fragmentos es minuscule

cubos con lateres de un millesime centi metro le superficie total devenl 0,6 metros quadrate Con tal superficies le reaction del parte del corpore es multo marcate Isto ex plica le ultime fallimento de prostheses de materiales del typo de nylon

Inter le metallos vitallium e aciero immac ulabile de certe requirite compositiones es familiar Titanium in forma pur o quasi pur es etiam un metallo que pote esser usate sed in comparation con le altere duo illo offere nulle evidente avantages Prostheses que es travaliabile al machina pote esser facite ex aciero immaculabile Prostheses de forma complexe es melio fundite in vitallium

Le fabrication debe esser manipulate de maniera cautissime. Nulle del requirite processos debe alterar le qualitates physic e chimic del metallo usate Abrasivos, per exemplo pote afficer le qualitates de metallos specialmente de aciero immaculabile, e debe esser empleate cautissimemente

In evalutar le resultatos obtenite con varie typos de prosthese, solmente tal successos e fallimentos es significative que occurre post que un prosthese de fabrication correcte es inserite correctemente in un patiente con normal metabolismo Fallimentos debite a un incorrecte mechanica o a un incorrecte inser tion es sin valor statistic inevalutar le ef ficacia de un specific typo de prosthese Le mesmo es ver si le fallimento del prosthese occurre in un patiente con negative balancia metabolic qui es incapace a reager normal mente al presentia del prosthese

Del altere latere le facto que un prosthese functiona ben a certe tempores o a multe tempores o mesmo a omne tempores non prova que illo es mechanicamente correcte ni que illo es inserite correctemente

# 4

# The Technic for Insertion of Femoral Head Prosthesis by the Straight Anterior or Hueter Approach

ROBERT M O BRIEN, M D *

Discouraged by the uncertain often poor, results of internal fixation treatment of dis placed subcapital fractures of the femoral neck in the elderly the author—and indeed most orthopaedic surgeons in St. Louis—has been treating such injuries in persons over 70 years of age by immediate prosthetic substitution for the femoral head. Our first pa tient so treated underwent operation in January 1951

As it became evident that a very service able hip could be obtained with the pros thesis the age limit was lowered in some in stances to 65 The series now comprises over 100 fresh fractures handled in this manner by the author and his associates in the St. Louis University Group of Hospitals and at the St Louis City Hospital A full report of this group of patients has been published elsewhere [1] Here we are concerned with a detailed discussion of operative technic and preference as to type of prosthesis

Early in our series the posterolateral ex posure of Gibson and the anterolateral Smith Petersen approach were used and discarded later Both incisions involve muscle cutting or detachment, and, with either method, some type of postoperative immobilization is necessary

Hueter s anterior straight incision to be discussed here does not require muscle cutting or detachment and no postoperative immobilization is needed We have used this approach in every case since November, 1951 The Judets recommend this incision but they describe it only briefly in their writ ings [2,3]

In the beginning the Judet and the J E. M Thomson types of transfixing prostheses were used. As time passed, it was found that often the operated hip assumed a varus deformity and in no case did the functional results seem as good as with the intramedul lary stem type of prosthesis such as the Fred Thompson and the Austin Moore varieties

Since November 1951 we have employed the Fred Thompson prosthesis[4] almost ex clusively We have found no fault with its design and when difficulties arose they were due to errors in technic rather than to failure of the prosthesis or its principle

## OPERATIVE TECHNIC

**Position.** The patient lies supine on the operating table in such a way that when the *kidney rest* is raised the hips will hyperex tend. A sandbag of medium size is placed under the affected hip A large sheet is folded lengthwise to a width of 4 inches and placed across the patient s perineum and the ends are tied at the head of the operating table This sheet is used for countertraction when reduction of the hip is done after the

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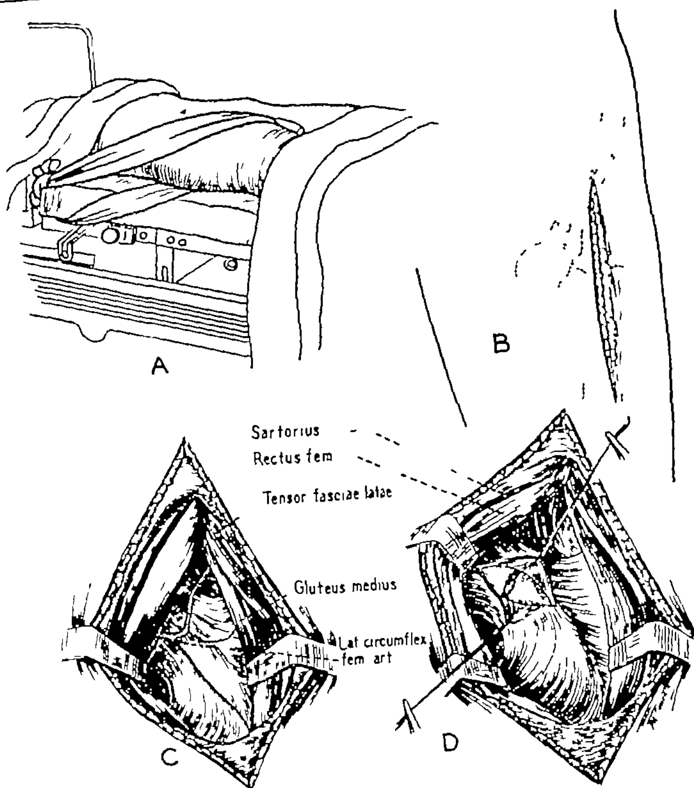



FIG 1 See text.

prosthesis has been inserted into the femur (Fig 1A)

Incision. The incision begins at the anterior superior spine of the ilium and extends downward about 6 or 8 inches along the line of the outer border of the patella (Fig 1B)

The *first landmark* is the lateral border of the sartorius muscle Dissect between it and

the tensor fascia lata to expose the *second landmark* the lateral border of the rectus femoris

Next, *isolate and ligate the lateral femoral circumflex vessels* They emerge into the wound from the undersurface of the rectus femoris muscle at a point just below the lesser trochanter They lie embedded in fat beneath a thin layer of fascia, continuous with that bounding the deep aspect of the rectus. This step is important. If these vessels are cut inadvertently they tend to retract beneath the rectus muscle and are difficult to ligate (Fig 1C)

Then, *flex the hip to relax the rectus and the psoas muscles* Retract the rectus muscle medially and *cut* its *reflected head* The anterior hip joint capsule now is exposed fairly well Make an incision in the capsule along the direction of the neck from the anterior acetabular margin to the intertrochanteric line (Fig 1D) We used to excise a good part of the anterior capsule We no longer do this unless special circumstances require capsular excision to get good exposure Unnecessary capsular dissection causes bleeding that may lead to wound hematoma

At this point flex, abduct and rotate the hip externally Next, *remove the head of the femur* This step can be vexing Judet's corkscrew is helpful but most often it is easiest to divide the femoral head into several parts with an osteotome and extract them piecemeal

After removing the head *break the kidney rest and hyperextend the hip* as much as possible *With a large curet, remove some* of the cancellous bone from the neck of the femur so that the cortex is well defined.

*With the hip in full flexion external rotation and abduction* (frogleg position), *the lesser trochanter will be pointing almost directly anteriorly*

It is necessary to *identify the lesser trochanter* preliminary to trimming the stump of the femoral neck

*Cut back the neck stump* with rongeurs *to a point about 1 cm proximal* to the superior border of the *lesser trochanter* Proper revision of the neck is the *secret of the operation*

*Failure to trim off enough neck* will make reduction of the hip very difficult, and it may *cause a disastrous fracture of the femur* through the base of the neck, the trochanteric and the subtrochanteric areas, when reduction of the femur is attempted after the prosthesis is inserted This type of fracture is comminuted, and it occurs longitudinally, the result being an obviously difficult situation.

*If too much neck is trimmed away, the reduction will be unstable* and postoperative immobilization of some type will be required to prevent dislocation. Also abduction leverage will be lost through excessive shortening of the neck.

After the femoral neck is shortened and reshaped, cancellous bone and marrow contents are curetted from the stump of the neck, the intertrochanteric and the subtrochanteric areas A Hoke spoon and a long large curet are good tools for this

Now it is time to make a trial insertion of the prosthesis

### Selection of Prosthesis

Two sizes of heads are available in the Fred Thompson prosthesis 1¾ inch and 1⅞ inch as well as right, left and neutral types The right and the left are made with anteverted necks the neutral with a straight neck We believe that the anteverted type is unnecessary The straight-neck neutral type seems to work just as well and fewer prostheses need be carried in stock

As regards size select the prosthesis that approximates in size the patient's own femoral head. In most cases the 1¾ inch prosthesis is used in women and the 1⅞ inch in men

### Insertion of Prosthesis and Reduction

A properly selected prosthesis *should fit easily* into the *femur* No more force than a firm push with the hand should be needed to insert it A hammer should not be used

because to use one will risk splitting the femur The Judet potato masher" tool is helpful in inserting the prosthesis, and it can be used also to direct the prosthetic head during reduction

If the prosthesis does not fit easily into the femur, more bone must be trimmed from the neck or more material must be curetted from the marrow cavity During insertion, a definite effort must be made to *keep the distal tip of the prosthesis pointing slightly anteriorly*, otherwise, this tip may penetrate through the femoral cortex posteriorly and laterally in the subtrochanteric area

After the prosthesis has been introduced into the femur the *probability of easy reduction can be determined* by having an assistant pull the leg down in external rotation If the top of the prosthesis can be pulled down to a point opposite the top of the acetabulum reduction will be easy, if it cannot reduction will be difficult and may be dangerous in the sense that fracture may occur in the upper femur Three alternatives are available (1) trim more neck or (2) have the anesthetist deepen the plane of anesthesia or (3) give curare or a similar muscle-relaxant drug *A hip skid must not be used* for almost certainly it will cause fracture of the femur Almost always we use a short-acting curare type drug at this point to facilitate reduction.

After reduction of the hip has been accomplished, the stability of the reduction should be tested by extension, external rotation and adduction of the hip If the prosthesis has been inserted properly dislocation will not occur and no postoperative immobilization will be required

### Wound Closure

After thorough saline irrigation the wound is closed in layers One or two sutures may be used to reattach the divided reflected head of the rectus femoris

### Wound Hematoma

Wound hematoma is a constant danger because of the oozing of blood from the medullary cavity of the femur and the dead space in front of the hip The collar of the prosthesis will fit tightly against the stump of a properly trimmed neck and tend to prevent oozing of blood from the medullary canal of the femur The avoidance of unnecessary incisions into the hip joint capsule will diminish bleeding also Careful hemostasis wound irrigation and a massive fluff-gauze pressure dressing all help to prevent hematoma

### Postoperative Care

Before the patient leaves the operating room both legs are bound with elastic bandages from toes to knees in the hope of preventing phlebothrombosis of the calf veins The bandages are left on until the patient is moving his legs and contracting his muscles actively

As already stated no postoperative immobilization should be required in the case of a fresh fracture

The patient may sit up in a chair as soon as desired, and attempts at walking with full weight bearing may be begun as soon as he has recovered from the anesthesia Some patients will begin to walk with assistance 3 or 4 days after operation. A few have walked well, alone and without crutches, in 2 weeks The sooner function of the operated hip can be resumed the less muscle atrophy there will be

## SUMMARY AND CONCLUSION

"The unsolved fracture" may not find its final answer in prosthetic substitution for the femoral head however progress has been made and this procedure gives a serviceable hip The author prefers it to the uncertain results of treatment by internal fixation of displaced subcapital femoral neck fractures in the elderly patient.

The age of 70 years was chosen in this series to select patients who would have prosthetic substitution rather than internal fixation. Later in some instances prostheses were applied to persons as young as

years The physiologic age of the individual patient and the nature of the fracture are important deciding factors

From experience gained in a large series of cases of prosthetic substitution for femoral head in fresh femoral neck fractures a satisfactory operative technic has been evolved and is presented in detail. The author s preference as to type of prosthesis is discussed.

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3 ——— The use of an artificial femoral head for arthroplasty of the hip joint, J Bone & Joint Surg. 32B 166 1950

4 Thompson F R. Two and a half years experience with a Vitallium intramedullary hip prosthesis J Bone & Joint Surg. 36A 489 1954


## Le Technica del Insertion de Prostheses Femoro-Capital per le Methodo Hueter a Incision Antero-Directe

*Summario in Interlingua*


Le majoritate del chirurgos orthopedic in St. Louis tracta displaciate fracturas subcapital del collo femoral in personas de plus que 70 annos de etate per reimplaciar le capite femoral immediatemente per un prosthese

Usque al tempore del presente reporto un serie de plus que 100 nove fracturas ha essite tractate in iste maniera in le Gruppo de Hospitales del Universitate St. Louis e le Hospital Municipal del Citate de St. Louis.

Le presente reporto es concernite con technicas operative. Al comenciamento le exposition posterolateral de Gibson e le exposition anterolateral de Smith-Petersen esseva usate Plus tarde iste procedimentos esseva abandonate Ambes require sectiones o distachamentos muscular e ambes require usualmente alicun genere de immobilisation postoperative.

Nos nunc crede que le melior exposition es obtenite per medio del incision antero-directe de Hueter como illo es recommendate per Robert e Jean Judet. Con iste incision, nulle musculo es secate excepte le reflectite capite del musculo recte femoral e nulle immobilisation postoperative es requirite Multe patientes comencia ambular con assistentia alicun dies post le operation

Al comenciamento nos usava le prosthese de Judet. Nos lo abandonava plus tarde proque in multe casos illo tende a positionar se varmente Nos nunc prefere—e usa quasi exclusivemente—le typo de prosthese intramedullar de Fred Thompson.

# 5

# Treatment of Certain Subcapital and High Neck Fractures of the Femur by Primary Prosthetic Replacement

P L DAY, M D,* AND J J HINCHEY, M D †

It is a well accepted fact that the most satisfactory result obtainable in high neck and subcapital fractures of the femur is through early accurate reduction and nailing followed by healing without complication No other form of treatment produces comparable results. However it is often difficult to reduce these fractures and it is even more difficult to maintain the reduction during insertion of the fixation The ideal position of a steeply placed nail in the inferior posterior portion of the neck and the center of the head is desired. To accomplish this the procedure may be prolonged hazardous and more shocking than some patients can tolerate Uncontrollable rotation of the head that prevents coaptation of the fractured surfaces has been noted both prior to and during surgery It is due commonly to interposition of portions of the capsule or the presence of comminuted fragments at the fracture site such comminution is more extensive than that suggested by roentgenograms Extensive dissection necessary to control a small head or interfering structures is conducive to a high incidence of complications

## UNION VERSUS UNION WITHOUT COMPLICATION

Of these well reduced and well-nailed fractures approximately one third fail to unite and one fifth of those that unite develop aseptic necrosis or disabling degenerative arthritis.

A statistical analysis of the cases and the methods it not always adequate, and sometimes we arrive at incorrect conclusions In many published series of intracapsular fracture of the femur it is reported that a high percentage united This percentage is obtained by disregarding those patients who died in the hospital and prior to the period of follow up as well as those lost Omission of those who developed aseptic necrosis and degenerative arthritis leaves less than half of the total number studied considered to be good results. One large series of femoral neck fractures, in which 86 5 per cent were reported to have secured union contained only 43 6 per cent of instances of union without complication A compilation of results published in the *Journal of Bone and Joint Surgery* during the past 10 years reveals the fact that satisfactory union without complication was obtained in somewhat less than 50 per cent of patients Many different methods designed to facilitate union and to reduce the complications materially have been formulated, carried out and studied without success in decreasing the number of poor results.

## VASCULAR ANATOMY

The medial femoral circumflex artery long has been recognized as the principal capital blood supply The vulnerability of this vital artery explains the high incidence of avascular necrosis of the femoral head At present

*†San Antonio Texas.

years. The physiologic age of the individual patient and the nature of the fracture are important deciding factors

From experience gained in a large series of cases of prosthetic substitution for femoral head in fresh femoral neck fractures a satisfactory operative technic has been evolved and is presented in detail. The author's preference as to type of prosthesis is discussed.

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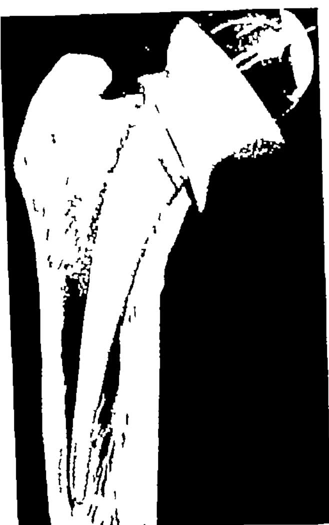


Fig 1 Intramedullary type prosthesis showing inferior portion of prosthesis resting on calcar femorale while lateral aspect of stem lies against medial surface of lateral cortex of femur and protects stump of neck against entire strain of weight bearing

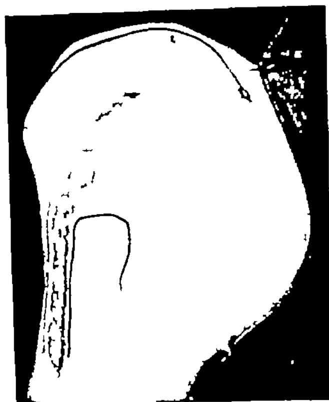


Fig 2 Intermuscular approach of Burwell and Scott. Exposure shows skin incision and landmarks

joint in front of or behind an intact gluteus medius and (2) procedures in which the continuity of the gluteus medius is divided at its origin or insertion We believe that the maneuver of displacing a relaxed gluteus medius provides early restoration of abduction power and minimal limp The lateral approach of Burwell and Scott seems to be ideal, and, basically it is that of Watson-Jones the difference being that the upper part of the incision is inclined backward instead of forward Rests or adhesive straps are used to stabilize the patient in the lateral position on the table with the affected hip uppermost With the surgeon standing be



Fig 3 Gluteal aponeurosis and iliotibial tract incised in line of incision

there is no practical method of determining the residual amount of blood supply to the femoral head at the time of fresh fracture Much experimental and clinical research with radioactive phosphorus is being carried out to answer this problem. Marked displacement or delay in reduction predisposes to all the complications The use of prostheses in fresh fractures may be indicated in those exceptional cases that can be predicted with some certainty will result in nonunion, aseptic necrosis or late degenerative arthritis

## SELECTION OF CASES

Although the age factor should not be used as the sole criterion for choosing primary replacement procedures certain elderly patients who otherwise are not good surgical candidates cannot withstand the double hazard of prolonged disability and extensive or multiple surgical procedures These same patients who initially are poor risks also are more prone to develop any of the complications of hip nailing The chances of their securing union of their fractures are fewer because of the decreased blood supply to the fracture site and the lack of good bone structure necessary for firm fixation. The immediate complications of death and loss of position at the fracture are commoner in them than in younger patients In the event of failure with the primary nailing, these older patients already have lost much ground in muscular tone vascular sufficiency and emotional stability which factors can influence adversely the result of any subsequent procedure indeed, they may be capable physiologically of surviving one major surgical experience but not two In selecting a primary prosthetic replacement for these patients the opportunity for the ideal or perfect, result is sacrificed in order to gain an early return to weight-bearing with a hip that is less serviceable but also is less prone to disabling complications

In discussing arthrodeses as being the last resort for some patients with old hip fractures Gill asked why then, it should not have been the first for them This same question may be easier to answer in regard to the use of prostheses

## CHOICE OF PROSTHESIS

It is realized that an implanted object, although biologically inert, never becomes incorporated into bone Smith Petersen has shown conclusively that the hip joint will tolerate weight-bearing and motion when forces are brought to bear upon it through a foreign body such as a Vitallium cup that will move freely between the acetabulum and the reshaped head of the femur

Intramedullary anchorage of the prosthesis is preferable because it seems to be the more permanently reliable method for guarding against looseness that results from bone destruction, and it prevents angulation in the coxa vara. The most suitable is a one-piece type that cannot come apart within the body Just as one emphasizes the mechanical advantages of placing a Smith Petersen nail low, resting near or on the calcar femorale, the same general principle applies in the use of prostheses The intramedullary type has the added advantage that the inferior portion rests directly on the calcar while the lateral aspect lies against the medial surface of the lateral cortex of the femur protecting the stump of the neck against the entire strain of weight bearing (Fig. 1)

The Austin Moore prosthesis is considered to be ideal, in that bone may grow intimately about it, reinforcing it in the same fashion as steel is reinforced by concrete The objection from the standpoint of engineering, that the perforations would weaken the stem materially has not been borne out by our experience of nearly 200 cases In other large series of cases of use of the intramedullary type not a single incident of fracture of the prosthesis is reported

## SURGICAL APPROACH

Surgical approaches to the hip joint for prosthetic replacement fall into two main groups (1) procedures that approach the

hind the patient an incision is begun from a point 3 inches in front of the posterior superior iliac spine curving to a point just anterior to the prominence of the greater trochanter thence downward along the shaft for a distance of 6 inches The gluteal aponeurosis and the iliotibial tract are incised in the line of the incision The tensor fascia femoris is retracted forward the gluteus medius, backward The capsule is incised, and the head is removed prior to shaping the remaining neck for insertion of the prosthesis (Figs 2 7)

We have utilized curare preparations for those portions of the procedure that require maximum relaxation, feeling that it has been responsible for less extensive dissection and for prevention of damage to the gluteus medius or its nerve supply

The size of the head of the prosthesis should be as nearly exact as possible This may be determined by direct measurement of the removed head, by the use of graduated disks fitted into the acetabulum or by selection of a suitable prosthesis after trial placement in the acetabulum It is important not to get added length at this time, since it may lead to difficult reduction of the hip with its associated danger of fracture and the late development of pain It is preferable to remove a portion of the neck rather than risk these dangers Following reduction of the hip by internal rotation, extension and abduction, closure of the wound is facilitated by maintaining the extremity in that position

In the light of serious objections made to the use of curare additional comment is warranted in evaluating its advantages and disadvantages for such procedures One study of the deaths associated with anesthesia and surgery reported 1 death in every 370 patients given a curarelike drug, as compared with 1 in 2 100 who did not receive the drug. However in 78 8 per cent of these "curare deaths, there was an error in the use of curare the choice of curare or the management of the anesthetic The question of cardiac arrest due to the use of the drug has been raised and in this connection it has been stated that it kills primarily by interfering with the ability of the respiratory muscles to move oxygen into and carbon dioxide



FIG. 8 (Case 1) Female 81 years of age, with high neck fracture showing extensive comminution at fracture site and probable interposition of capsule preventing reduction of fracture.

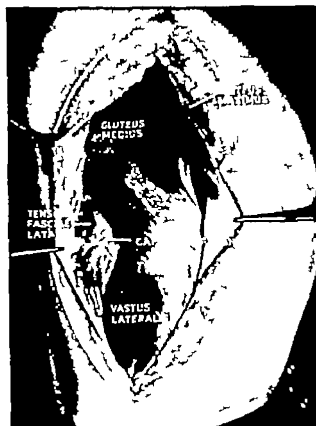



FIG. 4 Gluteal aponeurosis and iliotibial tract reflected



FIG. 6 Capsule incised and hip joint exposed prior to dislocation




FIG. 5 Tensor fascia femoris retracted forward and gluteus medius retracted backward to expose capsule of hip joint.

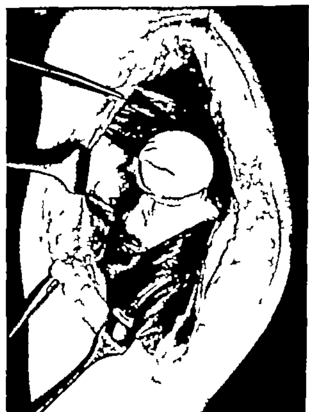


FIG 7 Head dislocated and ready to be excised or replaced. (FIGS 2 7 Burwell H N., and Scott Dan J Bone & Joint Surg. 36-B 105-106)



Fig 8 (*Cont*) Rotation.



Fig. 8 (*Cont*) Negative Trendelenburg in patient 4 months after insertion of left hip prosthesis for fresh subcapital fracture

from 1 to 10 per cent wound infection from 1 to 5 per cent. The incidence of dislocation reported frequently at 10 per cent, has been decreased materially with improvements in technics of exposure and repair Thrombosis or thrombophlebitis has occurred in essentially the same number as noted with ordinary hip nailings. Wound hematoma may be quite troublesome and it should be avoided by scrupulous attention to hemostasis throughout the procedure The presence of a large foreign body and a collection of blood surrounding it is a serious hazard to primary wound healing Further protection against



Fig 9 (Case 2) Female 84 years of age with high neck fracture.



FIG. 8 (*Cont*) Range of adduction.

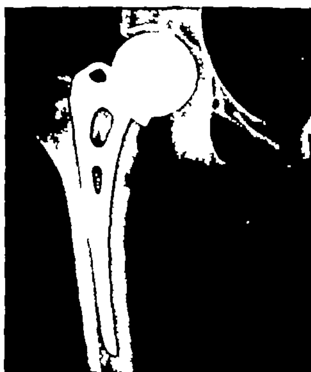


FIG. 8 (*Cont*) Austin Moore prosthesis in place.



FIG. 8 (*Cont*) Postoperative range of abduction

out of the lungs In competent hands it may be used without excessive fear of such a complication

COMPLICATIONS AND RESULTS

Those complications arising during surgery consist of fracture of the prosthesis and fracture of the upper end of the femur during insertion of the prosthesis or its reduction into the acetabulum We have had no instances of fracture of the prosthesis even though we have chosen the Austin Moore type which has been said to be weakened structurally at the stem due to its perforations. In one case a fracture through the trochanteric area occurred during insertion of the prosthesis. The separated fragment was transfixed to the major portion of the bone by a screw placed through that fragment one of the perforations in the prosthesis and the opposite cortex. Care in the technic of insertion of the prosthesis and complete muscular relaxation at the time of the reduction of the hip will tend to minimize the number of such fractures.

Mortality has been reported as ranging

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## Tractamento de Certe Fracturas Sub capital e Alto-Collar del Femore per Reimplaciamento Posthetic Primari

*Summario in Interlingua*

Nulle altere forma de tractamento in casos de Fractura subcapital e alto-collar pote esser comparate con le procedimento consis



Fig 9 (*Cont*) *Austin Moore prosthesis* in place.

hematoma formation is provided by com pression type dressings from toes to waist line in the pattern of a single spica

Some degree of calcification about the hip joint is noted in more than 50 per cent of hip cases but, significantly it is disabling in only a small percentage of these Pain is present in a similar number of patients and



Fig. 9 (*Cont*) Austin Moore prosthesis in place Trochanteric fracture occurred during insertion of prosthesis. Fracture fixed by transfixing screw Note opposite hip now fractured Note also supporting ledge of bone at inferior tip of prosthesis.



Fig. 9 (*Cont*) Bilateral Austin Moore prosthesis in place

it also is disabling in only a few there is a definite tendency for more of those with moderate or severe pain to improve steadily than for those with mild pain to increase Limp which is the most discouraging of all the late complications also shows a tend ency to improve under the adaptability of nature and time it has been appreciably less frequent with the advent of the intermuscular approach and muscular control through the use of curare

## CONCLUSIONS

We have been impressed favorably by the *functional results obtained through this pro*cedure The significant number of late re sults indicates a distinct possibility of producing return to all or nearly all the activities experienced by these patients prior to frac ture The best assessment of function is calculated by the effect on the everyday activity of the patient, and he though his appreciation may be limited by his lack of knowledge is still in a unique position to form a judgment.

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# 6

# Endoprostheses in Joint Lesions

W Russell MacAusland, M D *

There is no foregathering of orthopaedic surgeons today without a discussion of the subject of endoprostheses in joints Ever since the practicability of the replacement method was pointed out approximately 7 years ago the idea of restoring a faulty joint by substituting an artificial device has fascinated the surgeon.[9,10] The favorable results obtained by replacement arthroplasty of the hip have led to its acceptance as an approved method of treatment for the painful and mechanically defective hip joint. Efforts are being made to explore the possibilities of prosthetic reconstruction in other joints Here we are concerned with the application of the replacement operation to lesions of the shoulder the elbow and the metacarpophalangeal joints.

It is not difficult to explain the popularity gained by replacement arthroplasty The procedure has proven repeatedly its efficacy in creating a new hip joint that is painless stable and mobile The technic is relatively simple for the well trained surgeon. Recuperation from the operation is rapid, and pain is minimal. The method involves little danger to life and little risk of operative infection Because of the simplicity of the technic which reduces operative shock to the minimum and because of the rapidity of recuperation and the freedom from pain during convalescence the method is considered to be particularly suitable for the elderly patient.

* Boston, Massachusetts.

## ENDOPROSTHESES AT THE ELBOW JOINT

Personal experience in replacement surgery at the elbow based upon 8 cases, has shown that the procedure has wide applicability at this joint Now it is possible for the surgeon to envisage a solution of treatment for various difficult lesions that in the past presented a challenge

Two of the 8 patients in the series had unstable and painful elbow joints due to loss of bone substance at the lower end of the humerus Up to the present time the patient with such a lesion who is handicapped severely could be offered little hope of relief In an occasional case such a bone defect may be the result of neglect of treatment or faulty treatment, but, as a rule a loss of bone substance is due to the removal of bone segments in the surgical management of a severe fracture or tumor

Two patients had painful unstable elbow joints with limited function as the result of comminuted intercondylar fractures Previously no adequate method of restoring a satisfactory joint in cases of generalized disorganization of the humeral extremity was available Sometimes resection is practiced, but it is a method to which the author has objected constantly because of the likelihood of creating an unstable joint Arthroplasty with interposition of free fascia lata is contraindicated, for the reason that the proper remodeling of the humeral surface would entail the removal of so much bone that the

tente de precoce e accurate reduction e clavamento le qual es sequite per curation sin complicationes Le position ideal del clavo es un position fortemente descendente in le portion infero-posterior del collo e del centro del capite Iste position es desirabile sed difficile a attinger illo es extrememente hasardose in certe patientes de etate plus avantiate Factores responsabile pro le difficultate del reduction e pro subsequente complicationes es le incontrolabile rotation del capite e le disturbation causate per structuras del typo de comminuite fragmentos o portiones del capsula al sito del fractura Mesmo inter fracturas que es ben reducite e ben clavate circa 50 pro cento non resulta in union o disveloppa necrosis aseptic o invalidante arthritis degenerative Le publicate resultatos del tractamento de iste typo de fractura non include in multe casos le patientes qui mori tosto o qui escappa a re-examines posterior o le patientes qui disveloppa complicationes subsequente

In certe casos le reimplaciamento prosthetic primari es indicate in tanto que illo evita le secundari procedimento reconstructive Illo resulta in un coxa que es non integremente ideal sed iste coxa es usabile e le intervention chirurgic es minus extense

Es seligite le typo intramedullar de prosthese proque illo offere un protection contra le relaxamento que resulta del destruction del osso e proque illo evita le angulation del coxa verso le position var Iste typo de prosthese resta directemente super le calcar e tocca le superficie medial del cortice lateral del femore e assi protege le trunco fracturate del collo contra le integre effortio de supportar le peso del corpore

Un incision intermuscular servi a exponer le articulation del coxa posterolateralmente e con le uso de preparatos affin a curare le prosthese es inserite con minus extense dissectiones e un minus grande risco de lesiones al musculo glutee medie o su connexiones nervose Un adjustation exacte sed non excessivemente stricte es determinate per le mesuration directe del excidite capite o per medio de altere technicas de mesuration.

Complicationes que ha occurrite durante le intervention chirurgic include fracturas in le area trochanteric durante le insertion del prosthese o le reduction a in le acetabulo Nulle prostheses ha essite fracturate ben que prostheses del typo Austin Moore esseva usate del quales on dice que lor fortia structural es reducite per le presentia de perforationes in le trunco Le complicationes usual del chirurgia de articulationes coxal es plus o minus identic con le complicationes in ordinari clavamento coxal Hematomas del vulnere pote esser evitate per scrupulose mesuras hemostatic e per le uso de bandages compressive Calcificationes circa le articulation coxal, dolor sub peso e claudication persistente esseva observate minus frequentemente e in formas minus sever quando le methodo del incision intermuscular esseva usate E iste complicationes in tanto que presente tendeva a meliorar se post un o duo annos plus tosto que devenir progressivemente pejor

Le resultatos functional obtenite per iste procedimento esseva extrememente incoragiante Le procedimento es recommendate como procedimento primari in certe patientes riscose con fracturas subcapital o alto-collar del femore

than arthroplasty, so that the amount of circulatory and tissue reaction is reduced The convalescence is much shorter and relatively free from pain in contrast with the slow and usually painful recuperation from an arthroplastic procedure Motion may be started early after the replacement operation usually about the tenth postoperative day in contrast with the delay of 4 weeks after arthroplasty

The outcome in 4 of the 8 cases may be appraised after a postoperative interval of from 1½ to 3½ years, and in the 2 arthritic cases after 6 and 10 months respectively One patient died not long after the elbow operation as the result of another lesion. In 1 of the 2 cases of long-standing intercondylar fractures there had been concomitant nerve damage and because of persistent pain after the replacement operation, it became necessary to remove the endoprosthesis

The 4 patients whose elbows were operated upon from 1½ to 3½ years ago have stable and painless joints with a good range of motion All 4 patients are well pleased with the result. Three of them are using the arm actively in their work. One of the former patients is a student, and he works part time in a store (Figs 1–4) another is a typist and pianist, and the third is a farmer The fourth patient, an older woman has full use of the extremity all motions approaching normal.

One of the 2 patients treated for an ankylosed elbow which had been of traumatic origin, made somewhat slower progress in recovering motion than the other patients At the present time, 6 months after the replacement operation, motion is free and painless from 15° above the right angle to 20° below The other patient treated for an ankylosed elbow had suffered multiple arthritis for 5 years Both elbows were stiff and the patient was unable to feed herself Nine months after the replacement operation free and painless motion is possible from 45° above the right angle to 55° below In view of the general arthritic problem, this may be considered a fairly satisfactory functional recovery The patient now is able to feed herself She is so pleased with the result that she has requested an operation upon the other elbow



FIG 3 Same patient as in Figure 2 after replacement operation Marker indicates the condylar area of the prosthesis (MacAusland W Russell Am J Surg 85 168)

The literature contains few reports of ex



FIG 4 Range of flexion and extension after replacement operation 3½ years previously (MacAusland, W Russell Am. J Surg. 85 169)

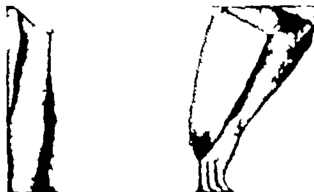


FIG 1 Deformed and unstable elbow caused by a bone defect of the distal end of the humerus

stability of the joint would be endangered.

One patient had an ununited fracture situated in the supracondylar region, as well as an ankylosed elbow The fracture was so close to the joint surface that the insertion of a bone graft was precluded. This patient s arm because of the painful and unstable joint, would be of little use to him for the remainder of his life

The sixth case in the series was a recent intercondylar fracture with extensive traumatic derangement of the joint. Every surgeon who has had occasion to treat a fracture of this type has longed for a more satisfactory method of treatment than the procedures hitherto available Reduction often is impossible and even when fair alignment of the fragments can be obtained the functional result generally is poor Little has been offered in the way of alternative treatment Complete resection endangers the stability of the joint, and excision of the fragments alone leaves a distorted articular surface that is incompatible with good function.

All the cases mentioned presented difficult problems of treatment which had not been resolved satisfactorily On the contrary the other 2 cases in the series were lesions for which there long has been a standard form of treatment Both patients had painful ankylosed elbows of arthritic origin a lesion that may be treated successfully by arthroplasty with interposition of a fascia lata flap The technic evolved by the author has given excellent results in numerous cases.



FIG 2. Bone defect of the lower humerus and abnormal head of the radius. The screw had been inserted in previous surgery (MacAusland W Russell Am J Surg. 85 168)

Departure from an accepted method of treatment must be weighed carefully A comparison of the routine arthroplasty and the replacement operation of the elbow reveals the following advantages of the latter method. The technic of prosthetic reconstruction is much simpler and less traumatic

The alternative treatment for these injuries at the shoulder has been resection of the humeral head which fails to restore satisfactory function The result is an unstable joint, and the abductor power is weak, even when the resection operation is supplemented by a tendoplasty or transplantation of the insertion of the musculotendinous cuff to increase its lever action Bony proliferation develops eventually, and the joint becomes progressively stiff

Further indications for prosthetic reconstruction at the shoulder have been recognized in tuberculous caries ankylosed shoulders, aplasia and avascular necrosis of the humeral head and in bone defects resulting from resection for a tumor

Endoprostheses of various designs have been used in the replacements that have been carried out at the shoulder The regular femoral head prosthesis has been adapted to the joint in the majority of cases Some surgeons are of the opinion that an artificial head of this design is perfectly satisfactory at the shoulder joint, where the normal adaptation of the articular surfaces is itself relatively imperfect.

It is the author's opinion that the evolvement of a completely satisfactory endoprosthesis for use at the shoulder joint will take time Several factors must be considered in replacing the upper humeral extremity in traumatic cases. In the first place the stability and the function of the joint depend upon the integrity of the musculoligamentous apparatus hence it must be respected. When the fracture line traverses the surgical neck, and when the entire upper humeral extremity is to be replaced, the artificial part must provide for the reattachment of the rotators and the supraspinatus muscle In fractures higher up a prosthesis of smaller design may be used this requires less sacrifice of bone and preserves the greater tuberosity with its areas of attachment for the muscles

The author has used 2 different types of endoprostheses in the 4 replacement operations that have been performed at the shoulder joint. A Judet femoral head endoprosthesis was inserted in the first case It was realized immediately that this type of device failed to provide for the reattachment of the muscles In the other 3 cases an endoprosthesis of special design was used this conformed in shape to the normal humeral extremity and contained a depressed area in the segment corresponding to the greater tuberosity where the muscles could be reattached After using this type of prosthesis, the author felt that a still more satisfactory artificial humeral extremity could be designed. The new model which is illustrated in Figure 5 will be used in shoulder replacements in the future

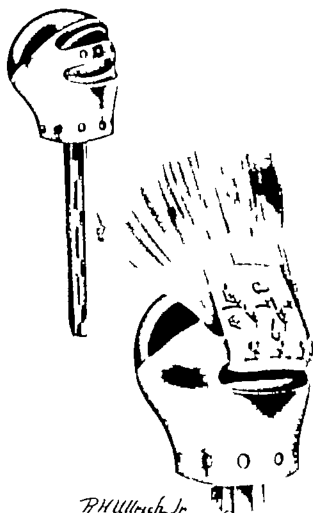


FIG 5 New design of shoulder prostheses to be used in future replacement operations.

The first case in the author's short series was a recent comminuted fracture of the anatomic neck of the humerus. This was the

perience in surgical replacement at the elbow Robineau[18] appears to have been the first to attempt prosthetic reconstruction of this joint, when he substituted the lower end of the humerus by a prosthesis of steel encased in rubber It was 16 years later before another attempt was made by Boerema and de Waard[1] In 1947 4 cases were reported by Mellen and Phalen[14] In 1951 and 1952 when attention began to be focused upon the possibilities of prosthetic reconstruction several cases of articular replacement at the elbow appeared in print.[4,19,20,22]

### Operative Technic

The introduction of an endoprosthesis at the elbow joint, unless the pathologic changes present contraindications is accomplished best through a posterior approach Wide exposure of the operative field is provided by sectioning the olecranon and retracting its proximal tip together with the attached triceps tendon Subsequent screw fixation of the olecranon fragments in closure permits motion to be started early without any danger of the separation of the fragments

The space to receive the prosthesis is prepared by removing a segment of bone from the humeral extremity a transverse surface being created This space should be approximately ⅛ inch deeper than the head of the prosthesis so that the new joint will be a shade looser than the normal elbow The endoprosthesis which is fashioned to conform in shape to the normal articular extremity is inserted by driving its stem into a drill hole in the center of the humeral shaft The wound is closed after flexion and extension movements have been tested gently

### Postoperative Care

Immobilization of the arm with the elbow at the right angle is maintained by means of a posterior plaster shell. On the third postoperative day the patient begins the exercise of making a tight fist. Motion at the elbow usually is free and painless by the tenth day The patient is discharged from the hospital about that time and he is given instructions to continue gentle movements of the elbow and to discard the plaster shell for longer periods as the joint becomes stronger The shell is removed during the third postoperative week, and a sling is substituted.

### Comment

The author is not advocating at this time the use of an endoprosthesis in every recent comminuted intercondylar fracture Indication for the operation is recognized only in a case of extensive traumatic damage when it is realized that the function obtainable by the customary measures of treatment could not possibly meet the demands to be made on the joint by the patient's occupation In the author's series of cases, the patient who had a prosthetic reconstruction for a recent intercondylar fracture earned his livelihood by playing the piano

## ENDOPROSTHESES AT THE SHOULDER JOINT

Severe fracture dislocations of the shoulder and comminuted fractures of the humeral head are types of injury for which the surgeon was certain one day to consider the possibility of using an endoprosthesis It is difficult to treat these injuries which occur frequently in elderly individuals As a rule it is useless to attempt reduction of a comminuted fracture of the humeral head and, when such treatment is undertaken, the result is a painful shoulder with limited motion A fracture dislocation of the anatomic neck of the humerus sometimes can be reduced accurately and the immediate result may be satisfactory but avascular necrosis of the humeral head is likely to ensue Reduction of a fracture dislocation of the surgical neck is possible when the fragment is large and more or less intact, and in a young or a middle aged adult, the functional recuperation may be fairly satisfactory On the other hand if the fracture is comminuted or if the patient is elderly functional loss is inevitable from either stiffness or aseptic necrosis of the humeral head.

The alternative treatment for these injuries at the shoulder has been resection of the humeral head, which fails to restore satisfactory function The result is an unstable joint, and the abductor power is weak, even when the resection operation is supplemented by a tendoplasty or transplantation of the insertion of the musculotendinous cuff to increase its lever action Bony proliferation develops eventually and the joint becomes progressively stiff

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It is the author's opinion that the evolvement of a completely satisfactory endoprosthesis for use at the shoulder joint will take time Several factors must be considered in replacing the upper humeral extremity in traumatic cases. In the first place, the stability and the function of the joint depend upon the integrity of the musculoligamentous apparatus hence it must be respected. When the fracture line traverses the surgical neck, and when the entire upper humeral extremity is to be replaced, the artificial part must provide for the reattachment of the rotators and the supraspinatus muscle In fractures higher up a prosthesis of smaller design may be used this requires less sacrifice of bone and preserves the greater tuberosity with its areas of attachment for the muscles

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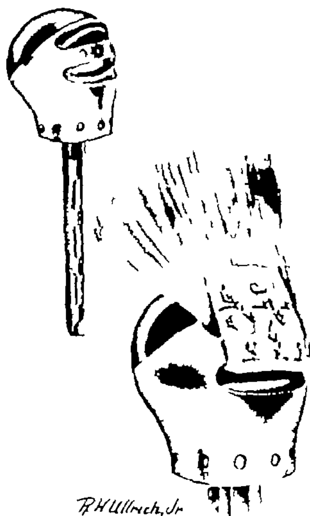


FIG 5 New design of shoulder prosthesis to be used in future replacement operations.

The first case in the author's short series was a recent comminuted fracture of the anatomic neck of the humerus This was the



FIG 6 Comminuted fracture dislocation of the shoulder

second injury that the patient had sustained in the shoulder region the first having been a comminuted fracture dislocation, which was not reduced. Upon exposure of the joint, it was observed that the musculotendinous cuff was a mass of scar tissue and that fibrosis was extensive A regular femoral head endoprosthesis was used to replace the upper humeral extremity

The result in this case is surprisingly satisfactory The patient has been followed up at regular intervals during the 4½ years since the operation. No pain has been experienced. The patient uses the extremity actively in her occupation as a housekeeper The loss of abductor power is compensated somewhat by scapular motion.



*FIG 7 The same patient as in Figure 6 after replacement operation The detached musculotendinous cuff has been attached in the specially designed concavity on the greater tuberosity*

The other 3 cases were fracture dislocations of the surgical neck of the humerus, 1 of which was combined with a fracture of the greater tuberosity A specially designed endoprosthesis was used in all 3 cases this permitted the reattachment of the rotator tendons and the supraspinatus It is to be regretted that the result cannot be evaluated in 2 of the 3 cases. Both patients who were aged 63 and 69 respectively ignored the instructions to carry out exercises that would preserve the power of abduction. As a result, the pectoral muscle group contracted, and voluntary abduction is limited to approximately 35°

The third patient was operated upon in March, 1954 At the present time 8 months after the replacement, the range of anteroposterior motion is practically normal, and

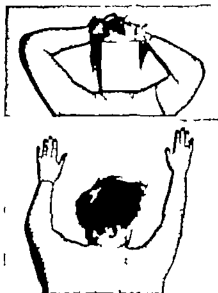


FIG. 8 The same patient as in Figures 6 and 7 eight months after replacement operation showing complete range of over head *motion possible when the arm is carried in front of the mid-line. Active abduction is free to within 15 of the horizontal.*

ve abduction is free to within 15° of the zontal Complete overhead motion is sible with the arm carried slightly for d of the mid line (Figs 6-8) The joint able and painless Rotational movement imited slightly

The experiences of other surgeons with replacement operation at the shoulder t have been encouraging.[5-8,11-13,15-17,21] e largest series of cases has been reported Judet, Judet and LaGrange who have d endoprostheses in 17 shoulders In the es were 11 traumatic lesions, 5 cases of erculous caries and 1 case of ankylosis of ritic origin. The remarkable feature of results is the freedom from pain 11 of 17 patients have no pain and in only 1 e is persistent pain severe Function ap-aches normal in the best results in the umatic group Satisfactory function was ained in the majority of the traumatic es abduction ranging from 30° to 40° l supplemented by scapular motion.

All 5 patients treated for tuberculous ies benefited by the replacement opera n. Disability was reduced considerably ause of the disappearance of pain All 5 ients regained better function abduction ng stronger and ranging from 40° to 60° mplete recovery of abduction was prohib-d by the atrophy of the deltoid, which is nstant in such lesions

A satisfactory result also was obtained in 1 case of an ankylosed shoulder the new nt being painless and stronger Atrophy the deltoid precluded the recovery of more mplete function.

## ENDOPROSTHESES AT THE FINGER JOINTS

Prosthetic reconstruction of a metacarpo-alangeal joint has been carried out suc sfully by the author in 1 case of a mal-ited fracture

### Case Report

The patient, a young man, had sustained the pical prizefighter's type of fracture of the stal end of the second metacarpal bone as the result of an injury while at work The frac ture was recognized by his physician and an attempt was made to reduce it A plaster cast was applied, and physiotherapy was carried out for several months



Fig. 9 Malunited fracture of the distal end of the second metacarpal bone (MacAusland W Russell Am J Surg. 85 170)

Ten months later when the author was con-sulted the metacarpophalangeal joint was pain ful, the finger weak, and the gripping power diminished. The patient who was a mechanic, had been unable to work since the time of the accident and was receiving disability compensa tion. Roentgenographic examination revealed a malunited fracture with the distal fragments im pacted on the metacarpal shaft and angulated palmarward (Fig 9)

Prosthetic reconstruction was carried out by a dorsolateral approach to the joint on the radial side (Fig 10) The joint was dislocated. The distal extremity of the metacarpal bone was sectioned transversely and a small drill hole was made in the metacarpal shaft to receive the stem of the endoprosthesis The artificial piece which had been modeled on the sound joint of the other hand but fashioned slightly smaller in size was introduced. The wound was closed,

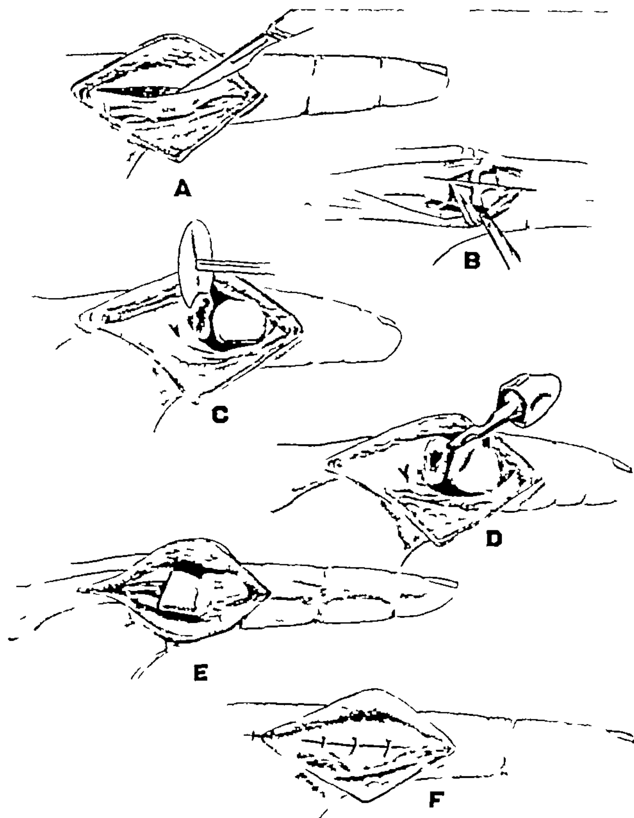



Fig 10 Technic of prosthetic reconstruction of a metacarpophalangeal joint. (MacAusland, W Russell Am J Surg 85 171)

and the finger was immobilized in the position of approximately full extension (Fig. 11)

The position of extension was maintained for 10 days. Gentle passive movements then were begun and the patient was encouraged to squeeze a soft rubber ball in the hand. Motion was regained under the supervision of a physiotherapist.

The recovery of function was rapid, and approximately 2 weeks after the operation the range of flexion was excellent. Five weeks after the operation the patient was able to use the hand normally and he returned to work The joint was stable and painless, and the range of motion was complete in extension and in flexion (Fig. 12) The power to grip had been re covered Function has remained unchanged up to the present time, approximately 3 years after the operation The former patient is highly satisfied with the result and he is doing heavy construction work.




FIG. 11 The same patient as in Fig ure 9 Prosthesis in position (MacAusland W Russell Am J Surg 85 172)

## COMMENT

A fracture involving an articular surface of a finger may cause considerable disability when the fragments unite in malposition. This is particularly true in the case of a per son who uses the hand in his occupation Not only is the joint painful but, also the function of the finger is impaired and the power to grip is reduced because of the dis rupted mechanics of the joint

The methods of resection and arthroplasty formerly were considered to be the only possibilities of treatment for a fracture disloca tion of the finger united in faulty position Resection, which endangers the stability of the joint, is not an accepted method of treat ment. Arthroplasty with interposition of a fascial flap has not been used to any great extent in treating finger lesions. The method has yielded some successful results but, as a rule the joint is unstable and function is impaired seriously following an arthroplastic procedure The author acknowledges that his experience with arthroplasty of the finger joints has been disappointing. The articular space is so small that the insertion of any material makes it difficult to close the capsule without drawing it too tightly There also is the danger of creating an unstable

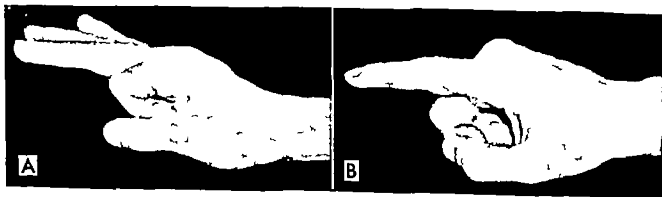



FIG. 12. The same patient as in Figures 9 and 11 three years after operation Com plete function in extension and flexion after prosthetic reconstruction. The joint is stable and painless. (MacAusland, W Russell Am. J Surg. 85 172)

joint because of the necessity of wide excision of bone to ensure free motion.

Little experience in the restitution of a finger joint by prosthetic means has been reported. The method can be considered only when the musculotendinous apparatus the nerves and the surrounding tissues are in good condition. Ward[22] has used the procedure successfully in 1 case of an ununited fracture dislocation of a proximal interphalangeal joint Burton[3] used acrylic prostheses in 4 cases of rheumatoid arthritis but it was too early to make end result observations at the time of his report

## SUMMARY AND CONCLUSIONS

The reconstruction of a faulty joint by substituting an endoprosthesis has become a popular method of treatment within the short space of 7 years since its introduction It is a procedure that is sound in principle and it has several advantageous features which are described There has been repeated proof of its efficacy in the handling of many intractable lesions of the hip joint, and its therapeutic possibilities in other joints are being explored more and more

The experiences of other surgeons in replacement surgery at the shoulder the elbow and the finger joints are reviewed, and personal experience of the application of the method to these joints is reported Indications for prosthetic reconstruction at these sites are outlined and the difficulties of treating the lesions concerned by procedures hitherto available are discussed.

The results in the author s series of cases have been most encouraging. Four of 8 patients who had replacement operations at the elbow have painless strong joints with a good range of motion and 2 others who were treated more recently have benefited decidedly by the operation The results have been favorable in the 2 of 4 replacements of the shoulder in which it was possible to evaluate the outcome An unusually good result was obtained by prosthetic reconstruction of a metacarpophalangeal joint.

The ground in this new prosthetic field has been well prepared. As time goes on, there will be further developments in the design of prostheses there will be improvement in technic, and new ideas will be acquired on indications for the method.

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## Endoprostheses in Lesiones Articular

*Summario in Interlingua*

Arthroplastia substitutive — si popular como methodo de tractar dolorose e mechanicamente defective articulationes coxal— ha producite resultatos incoragiante in certe lesiones del articulationes cubital, humeral e metacarpophalangeal Octo operationes substitutive esseva executate al cubito, 4 al hu mero e 1 al articulation metacarpophalan geal

Con le exception de 2 casos le lesiones representava problemas difficile de tracta mento pro le quales nulle previe solution— o al plus un solution inadequate—esseva disponibile Le casos exceptional esseva 2 cubitos ankylosate i.e un lesion que ha essite tractate con bon successo durante multe annos per medios arthroplastic. Le deviation ab le methodo standard esseva influentiate per le avantages del reconstruction prosthetic

In 4 del 8 casos cubital il esseva possibile evalutar le resultatos post un sufficiente intervallo de tempore e in omne istos le resultatos esseva excellente Le articula tion cubital es stabile e sin dolor e le limites del motion es satisfacentemente extense Duo del 4 patientes qui esseva tractate pro fractura con luxation del humero ha etiam nondolorose e stabile articulationes con movibilitate satisfacente Un resultato excellente esseva obtenite per le reimplacia mento del capite metacarpal In iste caso le functiones del articulation esseva completemente restablite Omne le patientes in iste serie es ben satisfacite con le resultatos Illes usa le articulationes in question de maniera active in lor occupationes

# 7

# Complications in Replacement Arthroplasty of the Hip*

## Experience With 68 Additional Cases

HOWARD MENDELSOHN, M.D., AND BERNARD N. BECKER, M.D.

Although it cannot properly be said that the tumult and the shouting have died, it is becoming evident that the din of controversy over the use of endoprostheses in the hip joint is just beginning now to generate *somewhat more light than heat.* Reports[1,3,4] of fairly large series of cases having from 3- to 5-year end-result studies have appeared in the medical literature and it is difficult to recall another reconstructive operation that has been performed so extensively in so short a period of time and one is tempted to add, without prior proof of merit.

We have had experience with over 100 replacement arthroplasties† of the hip 40 of which have been reported previously.[4] Here we are concerned only with the medical and the surgical complications encountered in a detailed analysis of the first 2 years experience with endoprostheses of the hip at the Los Angeles General Hospital Los Angeles, Calif From June 1951 through June 1953 68 prostheses were inserted into 66 patients The surgery was performed by various members of the attending and the resident staffs. The surviving patients have been followed from 18 to 42 months

TABLE 1

| NUMBER OF PATIENTS | SEX | | AGE |
|---|---|---|---|
| 66 | males | 10 | 38-94 |
| | females | 56 | 73 average |

| | |
|---|---|
| Preoperative Diagnosis | |
| Recent (less than 2 months) intracapsular fracture | 34 |
| Old (more than 2 months) intracapsular fracture with nonunion | 19 |
| Degenerative arthritis | 10 |
| Rheumatoid arthritis | 4 |
| Postradiation aseptic necrosis of the femoral head | 1 |
| | 68 |
| Types of Prostheses Used | |
| Judet (acrylic) | 50 |
| Judet (modified head and neck) | 4 |
| Eicher (metal) | 9 |
| Roger Anderson (nylon) | 5 |
| | 68 |
| Surgical Approaches | |
| Gibson | 42 |
| Smith Petersen | 14 |
| Hueter | 6 |
| Watson-Jones | 5 |
| Lateral | 1 |
| | 68 |

* From the Department of Orthopedic Surgery of the Los Angeles General Hospital, Los Angeles, California, and the University of Southern California School of Medicine

† Replacement arthroplasty if you wish, but by no means the tautologic "replacement prosthesis," since a prosthesis is an addition to the human body of some artificial part to replace one wanting as a leg, eye or tooth.[7]

Table 1 lists the number, the age and the sex of the patients, the preoperative diagnosis the types of prostheses and the surgical approaches Further comment regarding the data in Table 1 will appear in subsequent discussion The complication and the deaths encountered in this series are listed in Table 2

DEATHS (18%)

There was a total of 12 deaths 3 occurred in the first postoperative week. Nine patients died within an 8 week period they are considered to be operative mortalities because of progressive systemic deterioration that included pulmonary infections profound inanition with dehydration and extensive decubitus ulcers At no time did these 9 patients exhibit evidence of a satisfactory postoperative recovery

ANESTHETIC COMPLICATIONS AND HEMORRHAGE (19%)

Twelve anesthetic complications were considered to be serious enough to warrant inclusion in this study There were 9 cases of severe shock, 2 instances of extreme hypertension and 1 episode of prolonged laryngospasm The average anesthetic time was 146 minutes (75 315 minutes) There were no anesthetic deaths, and we were unable to correlate the length of anesthesia time with the incidence or the severity of complication We have included in this grouping 1 case of unusually severe surgical hemorrhage

TABLE 2

| Complications and Deaths | | | |
|---|---|---|---|
| Number of Patients | | | 66 |
| Number of prostheses | | | 68 |

| COMPLICATION | NUMBER OF COMPLICATIONS | NUMBER OF PATIENTS | PERCENTAGE OF CASES |
|---|---|---|---|
| Postoperative deaths | 12 | 12 | 18% |
| Serious anesthetic complications and *hemorrhage* | *13* | *13* | *19%* |
| Technical errors | 12 | 12 | 18% |
| Improper choice of prosthesis (4) | | | |
| Improper placement of prosthesis (2) | | | |
| Fracture of the femur (6) | | | |
| Early postoperative complications | 43 | 33 | 50% |
| Dislocations (11) | | | |
| Infections (12) | | | |
| Hemorrhage and shock (5) | | | |
| Decubitus ulcers (5) | | | |
| Mental disturbances (4) | | | |
| Peripheral nerve damage (3) | | | |
| Delayed union of greater trochanter (2) | | | |
| Thrombophlebitis (1) | | | |
| Late postoperative complications | 34 | 28 | 40% |
| Paracapsular calcification (19) | | | |
| Varus migration of prosthesis (7) | | | |
| Acetabular erosion with superior or central migration (6) | | | |
| Fracture of the prosthesis (1) | | | |
| Erosion of calcar femorale with intramedullary migration (1) | | | |

114 Complications and deaths occurred in 53 patients



FIG. 1 Extensively comminuted subtrochanteric fracture that occurred during insertion of a Roger Anderson nylon prosthesis. Intramedullary insertion of the prosthetic stem was effected in order to immobilize the fracture



FIG 2. The subtrochanteric fracture occurred during surgery The dislocation first was noted 10 days after operation.

## TECHNICAL ERRORS (18%)

Under this heading is a miscellaneous group of 12 complications that occurred at the time of surgery Some of these complications may have been due to improper operative technic inadequate equipment or unavoidable surgical accidents There were 2 cases in which a previously existing hip nail tract prevented secure fixation of the prosthetic stem. Two cases presented obvious disparity between the prosthetic head and the acetabulum The prosthesis was inserted in excessive varus in 2 additional instances Fracture of the femur occurred 6 times at the level of the greater trochanter once in the subtrochanteric area 3 times (Fig. 1) and in the upper third of the shaft, twice

*This complication was associated exclusively* with the use of the intramedullary stem type *of prosthesis and it was sustained either dur*ing the insertion of the prosthesis (3 cases) or following attempts at relocation after in*sertion (3 cases)*

## EARLY POSTOPERATIVE COMPLICATIONS (50%)

Within the first 2 months after surgery exactly 50 per cent (33) patients suffered one or more complications There were 11 wound infections 8 of which presented extensive suppuration that led to osteomyelitis of the involved bony components. These infections were of such magnitude that all resulted in complete operative failure and further surgical procedures often were necessary Also encountered were 3 superficial wound infections, which healed rapidly and

presented no serious postoperative problem

Dislocation of the prosthesis occurred in 12 cases (Fig. 2) Five dislocations were posterior and 3 were anterior Four dislocations were associated with the above mentioned infections, and they were not classified as to type The remaining complications that occurred in the early postoperative period are listed in Table 2 and they will not be commented upon further

## LATE POSTOPERATIVE COMPLICATIONS (40%)

The commonest complication encountered in the entire series was paracapsular calcification that was demonstrable radiographically These areas of calcific or osseous density varied in size from a few millimeters to massive deposits that surrounded the entire hip joint (Fig. 3) While massive areas of paracapsular calcification were associated definitely with restriction of joint motion small or minimal deposits were not accompanied necessarily by loss of function

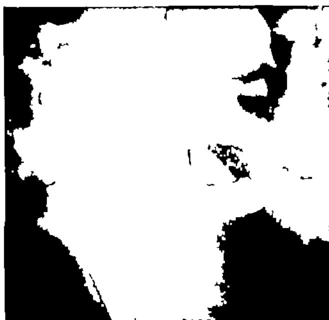


FIG 3 Extensive paracapsular calcification and varus migration of a Judet prosthesis

In 6 cases there was radiographic evidence of central and/or superior migration of prosthesis (Fig. 4) This migration occurred gradually over a period of months and produced acetabular erosion In 1 instance, the prosthetic head actually had created a secondary acetabular fossa (Fig. 5) When superior subluxation occurred instability of the hip was observed clinically Restriction of motion especially in abduction, also could be demonstrated in cases presenting marked central migration. In these cases serial roentgenograms revealed gradual approxima-



FIG 4 Judet prosthesis (*Left*) 2 months after operation and (*Right*) 20 months later showing increased central migration with acetabular erosion



FIG. 5 Eicher prosthesis. (*Left*) Three months after operation The prosthetic head has migrated superiorly and does not articulate with the acetabular fossa. (*Right*) Twenty-one months later showing creation of a secondary acetabular fossa with progressive superior migration and bony erosion

tion of the superior margin of the greater trochanter to the acetabular roof

Varus migration of the prosthesis occurred in 7 cases and only twice could it be attributed to excessive varus insertion (*vide supra*) In the other 5 cases, migration occurred gradually over a period of months *This complication was associated invariably* with excessive movement of the prosthetic stem absorption of the adjacent bony surfaces instability of the hip joint and severe pain on weight-bearing.

Fracture of the skirt and the stem of an acrylic prosthesis occurred in 1 case 18 months postoperatively This prosthesis was replaced subsequently Erosion of the calcar femorale with intramedullary intrusion of the cervical flange of an Eicher prosthesis was demonstrated in 6 months after surgery in 1 patient. No symptoms could be attributed to this occurrence

## DISCUSSION AND SUMMARY

The insertion of a hip prosthesis is not a minor procedure Some surgeons assert that this operation can be performed rapidly and with less difficulty than other reconstructive procedures on the hip joint. In this series, the 68 operations were performed by 37 orthopaedic surgeons whom we regard as representing a cross section of surgical ability and experience It may be true that 1 surgeon performing 68 such operations might *encounter fewer complications, but this study* reveals that the majority of complications are those inherent to major hip surgery of any kind Also it is unlikely that the use of other kinds of prostheses or variations in the surgical approach would alter appreciably the number or the type of complications encountered. Careful review of the cases in this series has tended to confirm these impressions

Specific complications can be expected to accompany the use of certain kinds of prostheses for example, fractures of the femur are associated more commonly with the use of the intramedullary stem prosthesis, while varus migration seems to occur characteristically with the Judet type of prosthesis.

*Replacement arthroplasty of the hip* connotes obviously an operation that should be

utilized for the purpose of rehabilitation, and it should be performed only on patients with rehabilitation potential It is not our inten tion to evaluate preoperative indications but in view of the dismal picture portrayed by this statistical survey it is our strong clini cal impression that this operation should be regarded as a procedure of last resort for carefully selected patients in the older age group Furthermore regardless of the p e operative indication the type of prosthesis or the degree of surgical proficiency one must contend always with the biologic fact that human joints do not tolerate well—and on many occasions they resent highly—the pres ence of foreign material

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## Complicationes in Arthroplastia Reimplaciamental del Coxa Experientias con 68 Casos Additional

*Summario in Interlingua*


Le presente reporto es concernite con le complicationes medical e chirurgic que esseva notate in un detallate analyse del duo prime annos de experientia con endoprosthese del coxa al Hospital General de Los Angeles inter junio 1951 e junio 1953 Esseva inserite 68 prostheses in 66 patientes. Complicationes occurreva in 53 del patientes. Le numero total del complicationes inclu dente 12 mortes esseva 114 Iste total in cludeva 11 luxationes 12 infectiones 5 casos de hemorrhagia e choc 5 casos de ulceres decubital, 4 disturbationes mental, 3 lesiones de nervos peripheric 2 retardationes in le union del trochanter major 1 thrombophlebitis 19 calcificationes paracapsular 7 casos de varation del prosthese 6 casos de erosion acetabular con migration superior o central, 1 fractura del prosthese 1 caso de erosion del calcar femoral con migration intramedullar 4 casos de misselection del prosthese 2 imperfecte insertiones del prosthese e 6 fracturas del femore

Nostre studio monstra que le majoritate del complicationes in le serie sub investigation esseva identic con le complicationes characteristic de omne typo de major chir urgia coxal Specific complicationes es a ex pectar in le uso de certe specific typos de prosthese Per exemplo fracturas del femore occurre plus communmente in association con le uso de prostheses a trunco intramedul lar durante que varation pare esser associate characteristicamente con prostheses del typo Judet.

Arthroplastia substitutive del coxa deberea esser considerate como recurso final in cautemente seligite casos de patientes a etates plus avantiate

# 8

# The Treatment of Osteoarthritis of the Hip by Means of the Prosthetic Type of Arthroplasty*

EDWARD L COMPERE, M D †

Osteoarthritis of the hip is synonymous with malum coxae or *morbus coxae senilis* hypertrophic arthritis degenerative arthritis wear and tear arthritis and arthritis deformans The weight bearing joints are involved most often and more severely Arthritis of this type is rare before the age of 30 and fairly common among patients more than 60 years of age It is a part of the aging process similar to graying of the hair wrinkling of the skin or arteriosclerosis Just as with graying of the hair in some persons the process manifests itself early in life in others late

The minimal traumas of life the wear and tear of everyday activities affect mostly the weight bearing joints Any articulation that is mechanically deficient will "burn out" much earlier than will one that functions perfectly Subluxation of the hip congenital dislocation Legg-Calvé Perthes disease and slipped femoral epiphysis each leaving deformity within the hip are among the more common causes of osteoarthritis of the hip Direct trauma to the hip joint, pre-existent rheumatoid arthritis pyarthrosis at an earlier period of life and aseptic necrosis of the femoral head may result in the development of osteoarthritis

A significant contribution to the surgical reconstruction of the arthritic hip was the development of the Vitallium cup arthroplasty by *Smith-Petersen* [16] *Moore and Bohlman*[1,14] first were successful in restoring strength and function by means of a metallic prosthesis replacement of the upper end of the femur Hudack[8] reported a study in articular replacement that proved to be of value to subsequent investigators of this problem The Judet brothers[9] devised a simple prosthesis made of acrylic later reinforced with a steel rod, which they have used successfully in a series of several hundred cases To the Judets[9] Verbrugge[18] and d Aubigne[12,13] must be given the credit for proving that the principle of replacement of a dead or a deformed femoral head, by means of a prosthesis constructed of materials that would be tolerated by the tissues of the recipient host, is practicable and can be used successfully in the treatment of many disabling conditions of the hip

Prostheses have been made of several materials including steel Vitallium acrylic and nylon To the Judet principle of a short stem supported by the neck of the femur and the outer cortex of the shaft has been added the principle of intramedullary fixation. It has been estimated that there are more than 100 different kinds of prostheses each varying in some respect from the other The Committee on Scientific Investigation of the American Academy of Orthopaedic Surgery[3] reported that 37 varieties of prostheses were being used and preferred by the surgeons who replied to their questionnaire Mc

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FIG. 1 Case 1 male, aged 49 Showing osteoarthritis of both hips September 9 1950 and a postoperative view approximately 1 year later with a Judet type of acrylic prosthesis, the stem of which is reinforced by a small steel rod The trochanter was slow in reattaching. Subsequent to the date of this roentgenogram the small threaded pin was removed and the trochanter has remained securely in position

Bride [11] MacAusland,[16] Thomson[17] and Donaldson, Sankey and Donaldson[4] have reported encouraging results in the use of hip prostheses.

When selecting a femoral head and neck prosthesis, and again when inserting it, 2 angles of the femoral neck should be kept in mind. The femoral neck is joined to the shaft at an angle that varies, but averages 125° For the prosthesis to function ideally this angle should not be *less* than 125° A much more difficult angle to obtain is the acute angle of torsion Sometimes this is called the anterior angle or the angle of anteversion of the neck. The prosthesis should be inserted so that when the hip has been reduced, the head will be anterior to the shaft, and a line from the center of the head to the shaft extends not only downward but also backward, joining the shaft at an angle of 125 to 140° with anteversion or angle of torsion of not less than 15° or more than 25 Dunlap Shands and their co-workers[5] and Ryder and Crane [15] working independently have described methods of measuring femoral anteversion They have re-emphasized the importance of the angle of torsion for satisfactory hip function.

The wise surgeon will weigh many factors before deciding how to treat each patient with osteoarthritis of the hip Indications for arthroplasty include (1) bilateral osteoarthritis of the hips—choice between fusion of one hip and arthroplasty of the other or arthroplasty of both hips (2) reduced or lost knee joint function on the same side (3) arthritis of the lumbar spine with limited mobility which makes hip fusion less desirable (4) other factors—economic, type of work done, refusal of patient to permit arthrodesis, inadvisability of prolonged immobilization.

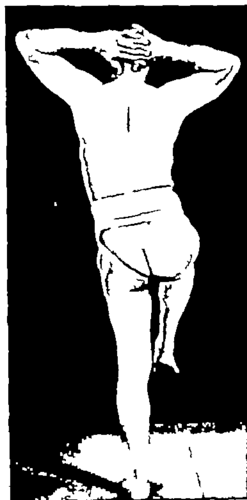
Insufficient neck of the femur dysplasia, advanced age or an occupation that requires heavy labor are not necessarily contraindications to a prosthesis replacement arthroplasty There are excellent prostheses that provide for absence of the femoral neck The sloping or shallow acetabulum may be deepened or shelved over Many elderly patients withstand the strain or shock of major surgical operations as well as do much younger patients Judet, Verbrugge d Aubigne and others (Cases 1 and 3 of this study) have reported success in rehabilitating many workers so that they were able again to do heavy labor The prosthesis should be chosen with careful consideration of the problem presented by each patient.

The following is an outline of the plan of treatment that the author has found to be most satisfactory

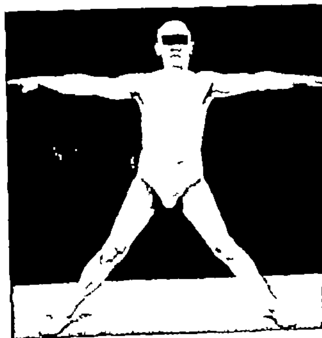
1 Posterolateral modified Kocher incision similar to that described by Gibson[7] (A) adductor tenotomy may precede the hip operation if adduction deformity is present,

FIG 2. Case 1 (*Cont*) Photographs were taken May 22, 1953 2 years and 8 months after replacement of the head of the left femur with a Judet prosthesis. The patient has no pain in the left hip the range of motion is normal, and he is able to do a full day's work with less tiring of the leg on the side of operation than of the unoperated extremity









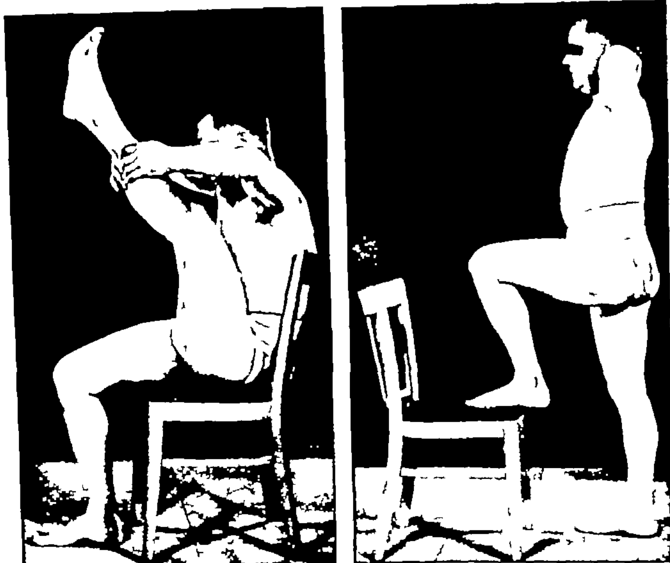


FIGURE 2 (*Continued*)

(B) neurectomy of the 3 branches of the anterior division of the obturator nerve if the patient has complained of pain in the anteromedial portion of the thigh.

2 If the posterior and superior capsule is diseased or edematous and thickened, it should be excised.

3 If the neck of the femur is preserved, the Judet or the Moore type of prosthesis may be used.

4 If the neck is short or absent, a Thomson or an Eicher type of prosthesis is preferred

5 The Eicher broach should be started where neck and trochanter join.

6 The prosthesis should be inserted so that the angle of anteversion will be approximately 15°

7 The angle of inclination should be at least 130° (the angle formed by the neck and the shaft of the femur)

8 Russell traction of 5 pounds for 5 days, with the leg abducted and rotated externally will lessen muscle spasm postoperative pain and the hazard of dislocation

9 Walking with crutches or a walker on the tenth day or as soon as patient co-operation will permit.

The lapse of time since the first prosthesis replacement arthroplasty was done is much too short for any statistical or end result study Each of the following cases is presented for the purpose of illustrating one or more of the lessons that we have learned and found to be of help in the surgery and the management of prosthesis arthroplasty pa



FIG 3 Case 2, aged 78 Extensive osteoarthritis with partial collapse of both femoral heads. Motion was limited to a few degrees. The lower roentgenogram shows the appearance of the hips following a Vitallium cup arthroplasty of the one and a prosthetic arthroplasty of the other The hip with the Vitallium cup has a greater range and less discomfort than has the hip in which the prosthesis was used *The angle of anteversion was not maintained when the prosthesis was introduced* and this accounts in part for the left leg limp

tients In every case of osteoarthritis of the hip the acetabulum is abnormal The extent of involvement of the acetabulum will influence both the prognosis and the choice of method of treatment.

*Case 1 G J* a male 49 years of age was examined September 7 1950 He complained of pain in both hips more marked in the left than the right, which had been present for a period of 2 years Roentgenograms showed osteoarthritis of both hip joints (Fig. 1 *left*) Both hip joints appeared to be slightly aplastic, and it was thought that the patient might have had congenital dysplasia that was not severe enough to produce recognizable symptoms earlier in life. The patient was a chauffeur and gardener and his work required him to b his feet for long hours. The pain had bec so severe that he had been compelled to fo much of his accustomed activity

September 13 1950 a bilateral ant obturator neurectomy and tenotomy of gracilis and the adductor longus muscles performed. Through an anterior approach, deformed femoral head was removed, ar Judet prosthesis of acrylic was inserted, the of which was reinforced with a metal rod. trochanter which had been removed as initial part of the procedure, was reatta with threaded wires The patient s course sequent to this operation was satisfactory cept that the threaded wires migrated and to be removed. (Fig. 1 *right*)

*Comment* This was the first patient whom the author did a prosthetic repl ment operation for osteoarthritis of the In September 1955 5 years after operat he is able to walk without pain or limp h ing excellent use of the prosthetic hip he fulfills all his duties as gardener and ho man on a large estate near Chicago (Fig. Because the neck of the femur was not volved, this was an ideal case for a Judet t of prosthesis

Case 2. L. R. male, with bilateral disabl osteoarthritis of the hips, was treated by c and prosthesis operations at 78 years of a He first was examined by the author on Ma 10 1946 because of progressive pain and st ness in both hips. Examination revealed o a few degrees of motion Roentgenogra showed arthritis of the spine and extens osteoarthritis of the hips superimposed up what appeared to have been old bilateral slipp femoral epiphyses. (Fig. 3 *top*) Bed re traction and crutches afforded minimal a only temporary improvement. January 1948 an intrapelvic obturator neurecto bilateral, was carried out. Relief from pain a result of this operation was not remarkab Fusion of either hip was inadvisable becau of the age of the patient and the arthritis of t lumbar spine

April 2, 1952, a Vitallium cup arthroplas was carried out on the left hip. April 16 195 an intramedullary prosthesis operation w performed on the right hip The neck of t right femur was not shortened as much as w believe now to be advisable in using the Eich prosthesis, and, as a result, the hip was reduce



FIG. 4 Case 3 male aged 64 (*Top*) Roentgenogram of hip showing aseptic necrosis and osteoarthritis following open reduction and bone graft for an ununited fracture. (*Bottom*) Roentgenogram following removal of the necrotic femoral head and insertion of prosthesis. This patient has obtained a result that approximates normal

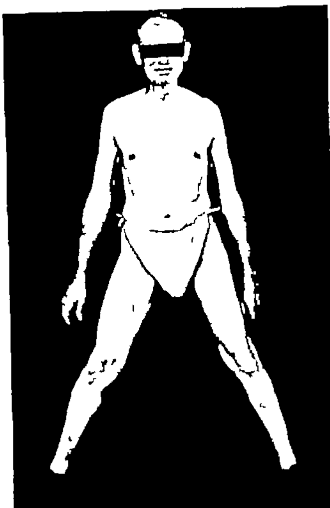


FIG. 5 Case 3 (*Cont*) Four and one half months after operation Motion is limited slightly in abduction but otherwise it is normal The patient has no pain and is working as a carpenter in the construction of buildings. He had not been able to work at his trade for more than 4 years before the insertion of the prosthesis.

with great difficulty Although this man was 78 years old at the time of the 2 operations, there were no operative or postoperative complications. (Fig. 3 *bottom*)

The patient re-entered hospital for treatment of a varicose ulcer on June 14 1953 14 months after the arthroplasty operations. He could walk without his crutches but with a limp in the right leg due to pain when full weight was borne. He walked well with the assistance of 1 cane, and motion and stability were good. The adductor longus and the gracilis muscles were tight and restricted abduction. A subcutaneous adductor tenotomy was performed on both sides. This patient has sufficient motion in both hips to sit comfortably in any type of chair He is able to dress himself and he considers himself exceedingly fortunate to have been rescued from a wheel chair so that now at the age of 79 years and 8 months, he is independent of help from others and is able to conduct his own insurance business. The limp and the pain in the right hip can be explained in part by the fact that the angle of anteversion was not maintained when the prosthesis was inserted.

When last heard from, 3 years after operation, this patient was doing very well and was too busy to return to Chicago for a checkup

Case 8 W C., 61 years of age, first was examined by the author on November 22 1949 because of an ununited intracapsular fracture of his left hip of 19 months duration. December 12 1949 an open reduction was performed and 2 fibular bone grafts were inserted with fixation by means of 4 threaded wires. Union occurred, but, as the patient became more active, the hip became increasingly painful. Aseptic necrosis of the head of the femur resulted in flattening of the femoral head and osteoarthritis of the hip joint. (Fig. 4 *top*) April 30 1952, the dead femoral head, which was found to be

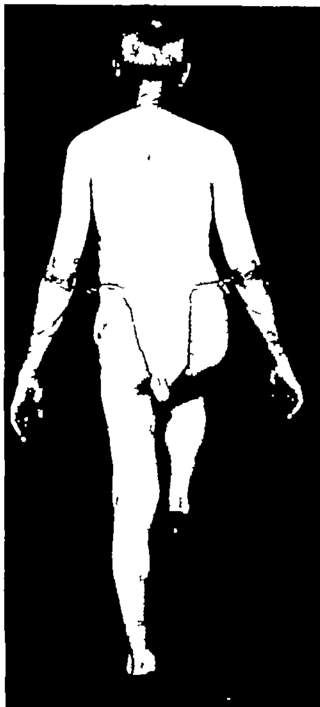


FIGURE 5 (*Continued*)



FIGURE 5 (*Continued*)

united firmly to the neck of the femur was excised An Eicher type of prosthesis was used. (Fig. 4 *bottom*) May 28 1952, 4 weeks after operation and 2 weeks after the patient had returned to his home in a neighboring city he was walking without the aid of cane or crutches. Discomfort was minimal Balance was good with a negative Trendelenburg

August 20 1952 less than 4 months after the operation this patient had an excellent gait, slight restriction of abduction but otherwise a normal range of hip motion For several weeks he had been working as a carpenter climbing ladders and working on scaffolding and buildings. He has continued with near normal function and would be judged an excellent result. (Fig. 5)

*Comment* The excellent result obtained in this case was due to a number of factors The acetabulum was not involved severely The choice of a head and neck type of prosthesis was essential because the femoral neck of the femur was too short to use the Judet type Perhaps equally significant is the fact that the angle of anteversion was maintained accurately at approximately 15°

Case 4 M W., female, 41 years of age, was examined on July 6 1951 because of pain in both hips, more marked in the right. A diagnosis of congenital dislocation of the left hip had been made during infancy but attempts at reduction were unsuccessful. There was marked limitation of motion in both hips with fibrous ankylosis of the left in a position of adduction and flexion. When the 2 legs were extended the knees could be separated only until they were 5 inches apart. Roentgenograms showed the

unreduced dislocation of the left hip and the fixed position of adduction and flexion There was dysplasia of the right acetabulum with loss of articular cartilage and osteoarthritis.

August 29 1951 a Vitallium cup arthroplasty of the right hip was performed followed on September 12, 1951 by an ischio-femoral tibial bone graft fusion of the left hip as described by Brittain The left hip became fused in excellent position with stability and freedom from pain The cup arthroplasty was a failure. The neck of the femur underwent absorption The superior margin of the cup impinged against the trochanter causing reactive bone formation that extended round the lip of the cup (Fig 6)

November 12 1952, 15 months after the cup arthroplasty the cup was removed and an Eicher prosthesis was inserted Recovery following this operation was delayed because of a temporary peroneal palsy produced by a knee sling. This patient has shown steady improvement in her ability to walk, with increasing ranges of motion and decrease in pain.

May 6 1953 approximately 6 months from the date of operation, she had excellent strength and stability for standing on her fused left hip active motion in flexion of 45 abduction of 20 and adduction of 10 in the right hip



FIG. 6 (*Right*) Case 4 female aged 41 Marked degenerative arthritis of both hips as a result of congenital dislocation of the left and dysplasia of the right. Both hips were painful and walking was very difficult.

(*Top*) A roentgenogram July 6 1951 at the time of first examination in the author's office The fixed adduction deformity of the left hip together with the dislocation, produced a functional shortening of more than 2 in. (*Center*) The left hip after osteotomy and fusion in a position of 15 abduction and a cup arthroplasty of the right hip The neck of the right femur has become absorbed inside the cup resulting in disabling pain. (*Bottom*) November 26 1952, after replacement of the cup with an intramedullary prosthesis. The length of the leg has been restored, and the functional result is satisfactory

Rotary motion was excellent with the leg extended, but limited with the hip in full flexion. Roentgenograms showed excellent position of the prosthesis She has shown steady and continued improvement, and now is able to do all her own housework.

*Comment* A patient with bilateral osteoarthritis of the hips who is less than 50 years of age and does not have arthritis of the spine can be rehabilitated by either arthroplasty on both hips or arthrodesis of 1 hip and arthro-

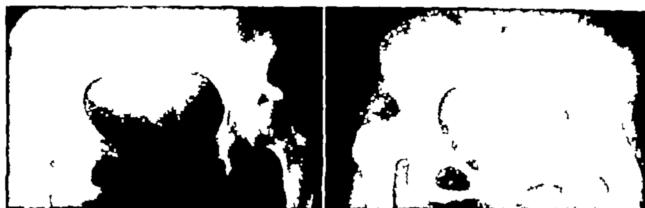


Fig 7 Case 5 aged 32 (*Left*) When first examined by the author on April 14 1938 because of pain in the left hip Roentgenogram showed congenital dysplasia of both hips, a poorly constructed shelf over the left hip deformity and osteoarthritis of the right hip (*Right*) On May 7 1951 13 years after fusion of left hip roentgenogram showed further degeneration and arthritic changes in the deformed right hip which then was very painful

plasty of the other The marked aplasia of the acetabulum and the deformity of the dislocated head and neck of the left femur make arthrodesis combined with osteotomy and correction of the adduction flexion deformity the procedure of choice

Case 5 E. C., 32 years of age a housewife, was examined on April 14 1938 because of difficulty in walking due to pain in the left hip and discomfort in the right hip She had been treated for congenital dislocation of both hips in early childhood. The right hip had been reduced, but repeated attempts to reduce the left had been unsuccessful. A shelf of bone above the displaced femoral head afforded little support. The author performed an arthrodesing operation on this unstable and painful hip with a completely satisfactory result

This patient continued to be active socially and to do her own housework. Thirteen years after the left hip fusion, May 7 1951 roentgenograms of the right hip showed marked deformity of the femoral head with flattening coxa vara, loss of cartilage space of the joint and osteoarthritis. An arthroplasty was suggested, but the patient was afraid of further surgery and, although she was severely disabled by the pain and the stiffness in her right hip she postponed the operation until late in 1952 December 12 1952, an Eicher replacement prosthesis arthroplasty on the right hip was performed. May 12, 1953 less than 6 months after the operation the patient was walking well, with good motion good stability and minimal discomfort. (Figs 7 and 8)

*Comment* Arthrodesis of the painful aplastic osteoarthritic left hip was carried out before present concepts of arthroplasty were known When the patient returned 13 years later with severe osteoarthritis and pain in the right hip the only choice was between osteotomy and arthroplasty

Case 6 R. P., male a railroad section hand, 21 years of age was admitted to hospital May 10 1953 because of inability to stand on or use the left leg He stated that at 10 years of age he suffered from pain in his left hip and had to use



Fig. 8 Case 5 (*Cont* ) Five and one half months after operation in which an Eicher prosthesis was used The hip is stable the range of motion is good, and the total result is satisfactory

crutches. When about 18 years of age he suf fered again from pain in the left hip and a limp About 1 year before he was admitted to the author s service a metal Judet prosthesis opera tion was carried out in a hospital in another city The pain and the disability were not relieved by the operation and examination re vealed restricted motion pain shortening of the leg and adduction deformity Roentgenograms showed that the prosthesis had been placed very poorly or had become dislodged after the opera tion. The stem of the prosthesis was at right angles to the shaft of the femur and was seated poorly on the femoral neck There was a shortening of the left leg of 2 inches (Fig. 9)

May 13 1953 an adductor tenotomy on the left hip was carried out. A threaded wire was inserted through the femur in the supracondylar region, and skeletal traction was applied After 2 weeks, the hip had been pulled down until the 2 legs measured the same length from the anterosuperior spine of the ilium to the tip of the medial malleolus The Judet type of prosthesis was removed, and a Moore Vitallium prosthesis was inserted. The Moore prosthesis was selected because adequate neck of the femur had been preserved This patient has continued to improve, but has a slight limp

*Comment* The faulty technic in the first operation precluded any chance of a good result. The stem of the prosthesis was in serted at right angles to the shaft of the femur instead of 130° to 140°



Fig 9 Case 6 aged 21 (*Top*) Illustrating faulty technic of insertion of a Judet type of prosthesis made of metal The neck of the femur was not prepared properly and the stem of the prosthesis was placed at right angles to the shaft of the femur The hip was so painful that no weight could be borne and this young patient was totally disabled. (*Bottom*) After adductor tenotomy traction to re store position and placement of the Judet metal prosthesis with a Moore Vitallium prosthesis, length was restored to normal, and function is very good

The intramedullary stem of one of 12 Eicher prostheses that we have used in the treatment of osteoarthritis of the hip showed in a roentgenogram bowing and a crack in the metal about 6 weeks after the patient began walking. Three months later fracture of the stem was complete and the broken prosthesis was removed and replaced by a new one of the same type with what appears to be a successful result.

We were interested to learn why a stain less-steel prosthesis that appeared grossly to be without a flaw when it was inserted should fracture We engaged the services of the Magnaflux Corporation, a company that specializes in the study of metals and their response to stress which made a detailed study of the broken prosthesis and of a second prosthesis of similar design and material that had not been used Both prostheses showed an inherently brittle structure and the microstructure showed transgranular cracking. Since no prosthesis known to us has withstood the stresses that follow their insertion in a hip replacement operation bet ter than has the Eicher the results of these tests would seem to indicate that some meth od of testing prostheses should be used by all manufacturers of these appliances before they are released for sale

The theory that the capsule of the hip joint is the main or the only source of pain as claimed by Gade is accepted widely There are pain nerve fibers in the medullary portion of a long bone and irritation or in

flammation of these fibers will produce pain Persistent pain or limp after the prosthesis arthroplasty should be considered to be presumptive evidence of a poorly chosen prosthesis or faulty surgical technic Pain or limp may result if the weight thrust of the prosthesis is against the endosteum or the inner cortex of the neck or the shaft of the femur Expanding pressures from within the medullary canal of a tubular bone produce pain.

The prosthesis should be seated firmly against the cortical edge over as wide a base as possible Coxa vara or anteversion of the femoral neck of more than 25° or less than 5° may result in a limp The less complicated the prosthetic appliance the greater the ease of insertion, the better the anatomic restoration of angles and leverage and the more secure the seating against strong cortical bone the more successful the end result will be

## CONCLUSIONS

1 In every case of osteoarthritis of the hip the acetabulum is diseased or deformed. The degree to which the articular surface can be made smooth is one factor that determines the end result.

2 The prosthesis to be used should be selected with care for each case

3 Only if there is an adequate femoral neck should the Judet type of prosthesis be used

4 For the short femoral neck the A. T Moore or the Thompson type of prosthesis is suitable

5 If there is no femoral neck, a head and neck prosthesis such as the Eicher should be selected.

6 For the patient younger than 50 years of age with bilateral osteoarthritis of the hip arthrodesis of the more severely deformed joint and prosthesis replacement arthroplasty of the other hip are advised

7 For the elderly patient with b[illegible] osteoarthritis of the hips and for the y[illegible] patient who also has osteoarthritis [illegible] lumbar spine replacement arthropla[illegible] both hips is recommended

8 The posterolateral incision of G[illegible] (modified Kocher) affords excellent [illegible]sure and it lessens greatly the chance o[illegible] sequent dislocation of the prosthetic h[illegible]

9 Limp may result from poor selecti[illegible] the prosthesis or careless alignment [illegible] prosthesis with regard to the 2 femoral [illegible] shaft angles or from pain

10 The prosthesis should be so ins[illegible] that the angle of inclination is at least [illegible] and the angle of torsion (anteversion) [illegible]proximately 15°

11 Pain may result from a poorly s[illegible]ed or an incorrectly aligned prosthesi[illegible] from any prosthesis that projects we[illegible] bearing against the inner wall of the m[illegible]lary canal of the femoral neck or the [illegible] of the femur

12 If adduction or adduction flexio[illegible] formity of the hip is present, adductor t[illegible]omy should precede the operation on the [illegible] Obturator neurectomy should be comb[illegible] with the tenotomy if spasm of the add[illegible] muscles and pain have been associated [illegible] walking.

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## Le Tractamento de Osteoarthritis del Coxa per Medio de Arthroplastia del Typo a Prosthese

*Summario in Interlingua*


Insufficientia del collo femoral, dysplasia etate avantiate o un occupation a rude labor non es necessarimente contraindicationes a arthroplastia a protheses substitutive Il existe excellente typos de prosthese que tene conto del absentia de collos femoral Si le acetabulo es pauco profunde iste defecto pote esser corrigite Multe patientes de etate avantiate supporta le choc e le effortio de major interventiones chirurgic tanto ben como patientes de etate multo plus juvene

Le typo de prosthese a usar debe esser seligite cautemente in cata caso individual Le typo Judet deberea esser usate solmente si le collo femoral es adequate Si le collo femoral es curte le typo A T Moore o Thompson es a recommendar Si le collo femoral es absente le prosthese a seliger debe esser un prosthese a capite e collo Pro patientes de infra 50 annos de etate suffrente de bilatere osteoarthritis coxal, un plano satisfacente de tractamento es arthrodese in le caso del plus severmente deformate articulation e arthroplastia a prosthese substitutive in le caso del altere coxa Pro patientes de etates avantiate suffrente de bilatere osteoarthritis coxal e pro patientes de etates plus juvene suffrente de osteoarthritis del spina lumbar le tractamento a recommendar es arthroplastia substitutive de ambe coxas. Le incision posterolateral de Gibson (un modification del incision de Kocher) resulta in un excellente exposition e reduce le risco de luxation del coxa prosthetic Un resultante claudication

esseva observate in casos de selection incorrecte del prosthese e etiam in casos de inexacte alineamento del prosthese in relation al duo angulos inter le collo e le diaphyse del femore Le prosthese deberea esser inserite de maniera que le angulo de inclination es al minus 135 a 140 grados e le angulo de torsion (anteversion) circa 15 grados

# 9

# Acetabular Reconstruction in Prosthetic Arthroplasty of the Hip

DUNCAN C MCKEEVER, M D, F A C S *

Prosthetic replacement of the femoral head has produced the largest percentage of satis factory results when used in hips having a normal or a nearly normal acetabulum that was not disturbed in any way at the time of operation Almost equally good results may be obtained in cases in which the acetabulum is reamed slightly in order to smooth it down and restore it to a hemispheric contour

In cases in which no acetabulum exists or the acetabulum is so damaged that the sub-chondral plate is penetrated either by the pathologic process or by necessary reaming, the results have been much less satisfactory This is true in such a high percentage of cases that it precludes a successful result in most of them In some cases the acetabu lum already is so large for one reason or an-other that no available prosthetic head will fit it. In other cases it may rapidly change contour and increase in size due to absorp-tion after the prosthetic head is inserted An accurate fit of the head in the acetabulum without the luxation that occurs when the head is relatively smaller is essential to a good result. In reaming out an entirely new acetabulum, the reamer has a natural tend-ency to drift in the direction of the softer bone while the reaming is taking place This tendency continues after the prosthetic head is inserted, so that even if the head fits accu rately the newly formed acetabulum at the time of the operation, absorption of the softer portions of the acetabulum takes place and within a few days or weeks it does not fit or progressive intrapelvic protrusion oc curs.

Some answer to the problem of the newly formed or the badly damaged acetabulum will have to be found if successful prosthetic arthroplasties of the hip are to be performed routinely in this type of case

A prosthetic acetabulum has been sug-gested and in some cases it may be feasible mechanically but, in its physiologic and me chanical effect on the opposed bone within the acetabulum it tends to act as an exten sion of the prosthetic head. It must subject the acetabulum to all the stresses that a pros thetic head imposes on the newly formed acetabular cavity though perhaps to a lesser degree because of increased surface area. The additional problem of friction between the prosthetic head and the prosthetic ace tabulum also is imposed in these cases Two metallic surfaces composed of the same metal cannot move on each other without friction, and further polishing of the opposed surfaces does not solve the problem, because, if the opposed surfaces conform exactly to each other in contour and are polished to maximum smoothness a molecular adhesion tends to take place between them and fric tion is increased rather than decreased

In industry oilless bearings have been made in which metal is opposed to a suitable plastic, as Teflon. These bearings run al-most indefinitely without visible sign of wear and it may be feasible to make an acetabu-lum or an acetabular lining out of Teflon

* Houston, Texas.



FIG. 1 (*Left*) Acetabulum enlarged by absorption and attrition of nylon head. (*Right*) Congenital dislocation in achondroplasia.

that could oppose a stainless-steel or a Vitallium prosthesis and wear indefinitely Here again the problem of maintaining the position of the prosthetic acetabular lining and preventing absorption or reaction due to mechanical pressure between the prosthetic lining and the opposed pelvic structures would have to be met. Such a prosthesis of plastic or any prosthesis of metal would have to be made self-retaining as there are structural mechanical reasons why a prosthetic acetabulum or any prosthesis cannot be fastened to a bone and made a functionally integral part of it by means of screws and other methods of rigid fixation. They must be self retaining, and they must maintain a physiologic ratio between surface area and stress.

A fairly thin cortical bone lining for a newly reamed acetabulum should give the acetabulum a more uniformly hard surface throughout and should resist absorption If such a lining could be formed from autogenous bone its prospect of maintaining itself successfully and permanently would be enhanced considerably because it would simulate the subchondral plate

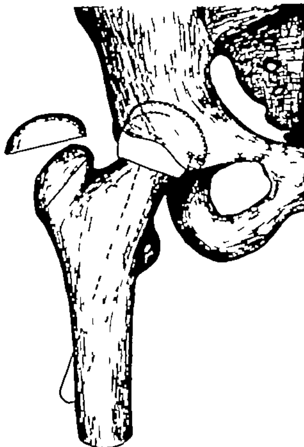


FIG. 2. Schematic drawing of portion of trochanter cut off reamed out and placed in acetabulum.



FIG. 3 (*Left*) Postoperative roentgenogram of patient shown in Figure 1 (*left*) Only a thin arc of lining is visualized The neck of the femur is packed with bone chips. (*Right*) Postoperative roentgenogram of patient shown in Figure 1 (*right*)

With this idea in mind the following procedure has been carried out in 2 cases In one the acetabulum had been damaged and enlarged extensively by mechanical attrition on a nylon prosthesis and by reaction to the powdered nylon abraded from the surface of the prosthesis The nylon throat section also had hollowed out the neck so that the stem wobbled in it, and this had caused some neck shortening. (Fig 1 *left*) The other case was one in which the acetabulum was constructed completely where no acetabulum existed. (Fig. 1 *right*)

In the first case the acetabulum was thoroughly cleaned out and reamed out to hemispherical contour with a reamer ¼ inch larger in diameter (⅛ inch radius) than the proposed prosthetic head In the second case an acetabulum was cut and reamed out where none existed.

All the muscle attachments on the outer surface of the greater trochanter were stripped off subperiosteally the abductors being left connected to the vastus lateralis Using a motor saw an oblique cut was made across the greater trochanter and a hemispherical piece about ¾ inch thick in the center was removed (Fig 2) Using a reamer corresponding in size to the proposed prosthetic head this piece of trochanter was reamed out to a thin shell averaging ⅛ inch thick, which then was placed in the acetabulum The prosthetic head was reduced into the acetabulum where it rested in the new cortical cup formed from the greater trochanter (Fig. 3) The muscles were reattached to the remainder of the trochanter

To date this new acetabular lining has maintained itself without absorption and both patients are ambulatory with crutches and able to walk without crutches part of the time This method is suggested as a means of relining the acetabulum and replacing the subchondral plate so as to prevent absorption, and within certain limits it will also reduce the size of the acetabulum so that a prosthesis can be fitted to it. If the

acetabulum is very large a new one can be made in the roof of the old one This was done in the case in which the nylon prosthesis was replaced by one of stainless steel

## SUMMARY

An autogenous cortical lining for a newly reamed acetabulum helps to prevent absorption of the innominate bone and intrusion of the prosthetic head into the pelvis. Such a lining can be formed successfully from a portion of the greater trochanter

## Reconstruction Acetabular in Arthroplastia Prosthetic del Coxa

*Summario in Interlingua*

Substitutiones prosthetic del capite femoral produce le plus alte procentage de resultatos satisfacente in le grupo de casos in que le coxa ha un acetabulo normal o quasi normal. Resultatos quasi equalmente bon es obtenibile in casos in que le contorno hemispheric del acetabulo pote esser restaurate per minor abrasiones. Del altere latere in casos in que le acetabulo es absente o si ledite que le processo pathologic o le abrasion chirurgic affice le placa subchondral le resultatos es multo minus satisfacente De facto in le majoritate de tal casos successo final ha remanite impossibile Il pote occurrer que le acetabulo es jam si large que nulle capite prosthetic pote conformar se a illo In altere casos le acetabulo cambia su contorno e augmenta su dimensiones in consequentia de absorption post que le capite prosthetic es inserite Precise conformation de capite e acetabulo es indispensabile pro bon resultatos.

In le correction chirurgic del contorno acetabular le plus molle portiones del osso es minus resistente e tende a esser plus fortemente afficite Iste mesme tendentia continua post le insertion del capite e le precise conformitate del capite que es attingite al tempore del operation non es necessarimente permanente Absorption pote terminar se in protrusion intrapelvic Il es imperative solver iste problema del novemente formate o seremente ledite acetabulo ante que le execution de arthroplastias prosthetic del coxa in casos de iste typo pote devenir un procedimento routinari que se termina routinarimente a bon successo

Le effecto physiologic e mechanic de un acetabulo prosthetic es identic con le effecto de un extension del capite prosthetic Illo exerce omne le stresses que es exercite per un capite prosthetic Illo pone in plus le problema del friction inter le capite prosthetic e le acetabulo prosthetic proque duo superficies facite del mesme metallo non pote mover se le un super le altere sin friction Iste problema non se resolve per un politura additional del superficies proque un politura de precision molecular resulta in adhesion molecular inter le duo superficies e assi augmenta le friction e non reduce lo

Capites de metallo pote esser combinate con acetabulos de un convenibile plastico con nulle resultante abrasion, sed un tal procedimento lassa intacte le problema de mantener le position del revestimento in le acetabulo prosthetic e etiam le difficultates inherente in le pression del acetabulo prosthetic super le osso Un tal prosthese de metallo o de plastico deberea esser construite de maniera que illo pote mantener se independentemente proque mechanic rationes structural rende impossibile que un acetabulo prosthetic o qualcunque altere prosthese es attachate al osso como un functionalmente integral parte de illo per medio de vites o non importa qual altere methodo de fixation rigide Tal prostheses debe haber un supporto independente e debe mantener un proportion physiologic inter extension de area superficial e effortio

Un tenue revestimento de osso cortical debe esser providite al chirurgicamente abradite acetabulo Un tal revestimento es uniformemente firme e assiste le acetabulo in resister al absorption que resulta de pression Un revestimento autogene de iste typo pote esser obtenite ab le trochanter major Iste procedimento esseva usate in duo casos. In un de iste casos le acetabulo esseva allargate

per le effecto abrasive de un prosthese de nylon Le secunde caso esseva illo de un nano achondroplastic in qui nulle acetabulo del toto habeva existite previemente Al tempore del presente reporto iste casos non exhibi ulle absorption ben que illos data de plus que un anno retro Iste genere de autogene revesti mento cortical es recommendate como un possibile solution del problema de revestir novemente construite acetabulos

# 10

# Acrylic Hip Endoprostheses

DANA M STREET, M D *

The desire to replace a diseased or a worn-out joint by a mechanically perfect indestructible artificial one always has been present on the part of both doctor and patient. The ideal prosthesis should fulfill five requirements (1) cause no reaction either electrolytic or allergic (2) restore normal mechanics, i.e lever arm, Shinton's line etc (3) have solid fixation since instability causes pain (4) conserve as much normal bone and ligamentous structure as possible in the event that an arthrodesis proves to be necessary (5) be durable from the standpoint of, a, breakage from strain or fatigue and, b wear Early attempts though promising, gave temporary good results because of deficiencies in materials.

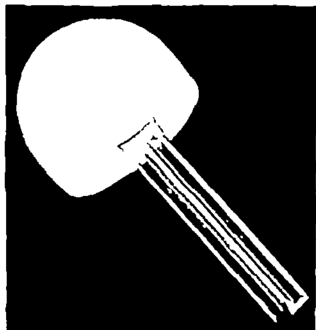


FIG 1 Type 1 prosthesis acrylic head with shallow recess hub at base of steel trifin nail

The first large-scale employment of this principle was in the work of Judet, who used methyl methacrylate as the material for the prosthetic femoral heads By standardizing his technic with special tools, he was able to shorten operating time and reduce shock within the tolerance of the elderly patient, and a minimum number of sizes of prostheses were required.

When the work of Judet first appeared in the literature we adopted a policy of waiting to see what the long-term results would be and resisted the temptation successfully for about 2 years to try this method. Then a patient appeared who stoutly refused a stiff hip and seemed to be an ideal candidate for a prosthesis His problem is presented in Case 1 Having available an excellent plastic shop that was used for the manufacture of acrylic artificial eyes we decided to make our own prostheses as we would be able to change the pattern according to indications

## TYPES OF PROSTHESES

The prosthesis used in Case 1 consisted of a head of thermal-setting methyl methacrylate molded on to a 4½ inch length of No 316 stainless-steel diamond shaped rod. The head resembled the Roger Anderson type it had no skirt This patient was improved so greatly that we were encouraged to repeat the procedure but we altered the design of the prosthesis to that shown in Fig-

* Memphis, Tenn.

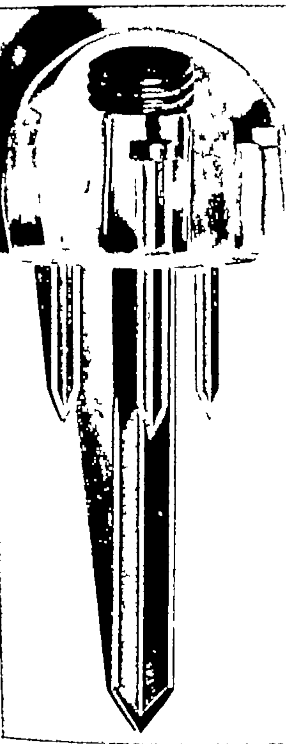


FIG. 2. Type 2 similar head to Type 1 3 small supplementary trifin nails placed to come within cortex of neck nails are Vitallium.



FIG 3 Type 3 acrylic head and neck, taper without abutment to allow settling to stable position steel diamond-shaped nail

ure 1 This which we have termed Type 1 consisted of an acrylic head on a stainless-steel trifin nail that resembled more the Naden-Rieth type The color was due to the addition of zinc oxide up to 2 per cent in an attempt to increase the roentgen shadow but without significant effect. A depression was made in the undersurface of the head by cutting a groove $\frac{3}{16}$ inch deep and forming a skirt with a thicker base than the Judet, the cross section being more nearly an equilateral triangle The depression or



FIG. 4 Case 1 (*Top*) Avascular necrosis following osteotomy (*Center*) Two months after insertion of prosthesis. (*Bottom*) After 2 years of ambulation without crutches.

cup was shallower than the Judet and considerably less than the Naden Rieth to restore neck length. A hub was left at the base of the nail to distribute stress at the junction of the head with the nail. With the trifin nail we hoped to obtain a more solid fixation in the cancellous bone and prevent rotation of the head while at the same time destroying less bone than the Judet type in the event that a secondary procedure was needed.

In the use of Type 1 in 12 patients, it seemed to lack stability particularly in 1 patient with considerable atrophy of the cancellous bone resulting from rheumatoid arthritis and prolonged bed rest. Therefore, it was decided to supplement the fixation with 3 small trifin nails placed peripherally so as to come just within the cortex of the neck, as seen in Figure 2 The head again was of methyl methacrylate in essentially the same pattern as Type 1 but the nails were of Vitallium instead of No 316 steel.

A third type shown in Figure 3 was designed for patients with short neck length or for those in whom Type 1 had worked loose The acrylic head in this type is extended into a long tapered neck that fills the space within the cortex of the neck and extends to just below the level of the lesser trochanter The No 316 steel diamond-shaped nail extends well below the isthmus in the medullary canal, stabilizing the prosthesis well against rocking and distributing pressure over a wide area of the lateral cortex to prevent erosion There is no ledge or stop on the neck to butt against the calcar as in most intramedullary types, since it was thought better to allow it to seat itself to a stable position and distribute pressure over a wider area. It also was thought that the stop might form a fulcrum for rocking, although because of the acute angle between the stop and the axis of the stem in both the Moore and the Fred Thompson types, the calcar forms a wedge that provides excellent stability at least when first inserted

## CASE REPORTS

The following representative cases are reported in detail for illustration

Case 1 J S a white male, 45 years of age was admitted October 10 1950 complaining of pain and stiffness in the right hip The hip and the pelvis had been fractured in 1945 An operation, apparently a high osteotome employing a Jewett nail was performed in 1949 On admission an adduction flexion deformity accounted for 2 inches of apparent shortening Motion was restricted to a few degrees in all directions and was very painful. An arthrodesis was advised, but it was refused

The patient was readmitted 8 months later and on July 9 1951 the hip joint was exposed through a lateral approach. The nail was found protruding from the avascular head and impinging against the margin of the acetabulum (Fig 4 *top*) The prosthesis first described was inserted in steep valgus (Fig 4 *center*) A hip spica cast was worn for 3 weeks to maintain correction of the adduction deformity and guard against dislocation Active assistive exercise and ambulation with crutches then were begun and weight-bearing was increased gradually to full by the end of the eighth postoperative week. Motion at this time was flexion 60 abduction 35° internal and external rotation 50 per cent of normal.

On June 15 1953 the patient was readmitted complaining of pain of 3 to 4 weeks duration following prolonged sitting or walking. Until then he had been without symptoms. Motion now was more restricted showing flexion of 20 extension of 10 and abduction of 10 There was marked atrophy of hip and thigh muscles Pain was relieved by a short period of rest, and the patient returned to work, which involved considerable walking and standing without the aid of a cane Eight months later he had to absent himself from work for 2 weeks to rest his hip which again had become painful.

The patient's condition on examination at 3 years was essentially the same as at 2 years (Fig 4 *bottom*) While he had not been free continuously from pain, he had been able to work was much improved over his former state and was well satisfied with the result thus far

There appear to be 2 reasons for the good stability of this prosthesis first, the density of the cancellous bone resulting from the osteotomy second, the valgus position It is noteworthy that there was no evident tendency toward dislocation with such marked valgus.

Case 2. W A. D a white male 60 years of age was admitted in 1948 shortly after fracturing the left femoral neck A Smith-Petersen nail was inserted, and the fracture united. Three years later the patient was admitted again with increasing pain and roentgen evidence of avascular necrosis of the femoral head (Fig 5)



Fig 5 Case 2 Avascular necrosis following union of neck fracture

On November 16 1951 the Smith-Petersen nail was removed, and the avascular head was resected through a Watson Jones approach A Type 1 prosthesis was inserted, the nail of the prosthesis being placed in the same hole from which the old nail had been removed (Fig. 6 *left*) The new nail fitted quite snugly providing excellent stability Some bony density that had appeared round the nail tract may have increased the support of the cancellous bone and may account for the fact that this prosthesis did not work loose.

Following surgery the patient wore a plaster boot with outrigger for 2 weeks, after which the limb was suspended for another 9 days. Physical therapy in the form of Hubbard tank dry heat and active exercise then was begun and continued for 1 month, during which weight bearing also was increased gradually The patient was discharged January 9 1952 he walked with a hardly perceptible limp without cane or crutches, and he had full range of painless motion less than 2 months postoperatively

On September 8 1953 or 22 months postoperatively readmission revealed that the patient had returned to work the day after discharge he had worked a full 9-hour day standing at a drill press 5 days per week, and had not missed a day of work. He had some aching pain if he



FIG 6 (Case 2 *Cont*) (*Left*) Type 1 inserted into old nail tract 5 months after insertion (*Right*) Forty months after insertion patient had been fully employed for 38 months.

stood or worked longer His range of flexion was 110 adduction internal rotation and external rotation were normal abduction was restricted to 10 All motion was painless.

Seen again on March 25 1955 40 months after surgery he had continued to work at the same job without loss of time due to his hip He walked without discomfort or limp. The range of flexion was normal extension also was normal abduction was 45 adduction was at least 25 internal and external rotation was restricted to 10 to 15 Push-pull roentgenograms revealed no loosening of the prosthesis (Fig. 6 *right*)

This has been our most successful case, and it is attributed to the adequate fulfillment of requirements 1 to 4 Regarding the fifth, time alone will tell, but the patient already has had nearly 4 years of excellent function.



FIG. 7 Case 3 (*Top*) Avascular necrosis following dislocation (*bottom*) after 3 months of full weight-bearing loosening has begun

CASE 3 J S., a Negro 22 years of age, was admitted on June 26 1951 History revealed a dislocation of the right hip 2 years before In spite of the fact that reduction was accomplished within 2 hours of injury the patient noticed stiffness 18 months later and he had constant pain at the time of admission.

Examination revealed a marked limp flexion of 90 with pain and crepitus internal and external rotation of 5 while abduction and adduction were nil. There was thigh atrophy shown by a 1½ inch difference in circumference 4 inches above the patella Roentgenograms revealed changes consistent with avascular necrosis of the femoral head (Fig. 7 *top*)

On July 17 1951 a Type 1 prosthesis was inserted through a short anterior or Hueter approach A hip spica was employed for 1 week and followed by suspension for 2 weeks. Exercise in the Hubbard tank and gradually increasing weight bearing then were begun



FIG 8 (Case 3 *Cont*) Twenty-one months after insertion marked rocking full weight-bearing without pain deepened acetabulum possibly related to period of drainage

At 2 months the patient continued to complain of sharp pain in the region of the greater trochanter only when bearing weight and localized tenderness was present where 1 flange of the nail protruded from the lateral cortex. This, therefore was removed through a short lateral incision However he could not be weaned from his crutches until 6 months after insertion of the prosthesis, and he developed marked atrophy of the glutei, the thigh and the calf muscles.

Roentgenograms at 6 months revealed the prosthesis to be stable in good position

During the second 6-month period the patient was bearing full weight and had less pain, but roentgen evidence of rocking of the prosthesis and deepening of the acetabulum began to appear (Fig. 7 *bottom*) Eighteen months postoperatively he developed swelling in the region of the lateral incision this drained spontaneously for about 1 week. This subsided promptly on administration of penicillin and Terramycin, and cultures were not obtained.

At 49 months the patient was found to have had no further drainage or pain. He was bearing full weight and was employed on a farm. Examination still revealed marked atrophy of the glutei and the thigh A ¾-inch lift compensated adequately for 1-inch shortening Motion revealed flexion of 100 abduction of 20 adduction of 30 internal rotation of 10 and no extension or external rotation—all with-







FIG 9 Case 4 (*Top*) Pseudarthrosis 2 years after arthrodesis. (*Center*) Four months after insertion of Type 2 (*Bottom*) Thirty five months after insertion no loosening unassisted ambulation with slight pain.

out pain. Push-pull roentgenograms revealed marked rocking and distraction of the prosthesis. Owing to the depth of the acetabulum the notch formed by the greater trochanter and the superior surface of the neck apparently was impinging against the rim of the acetabulum and providing rather satisfactory weight-bearing There was no further evidence of infection (Fig 8)

Case 4. C. P a white male farmer now 36 years of age sustained a fracture-dislocation of the left hip while in the Army in 1945 He was reduced promptly in traction and for 3 years he was asymptomatic Then he noticed shortening and instability of this extremity, but no pain Roentgenograms revealed evidence of avascular necrosis He got about on crutches for 2 years until January 1950 when a Ghormley type of hip fusion was performed through a Smith-Petersen approach. This did not become solid and again he walked with crutches bearing partial weight, for another 2 years, while it was hoped that he would develop a painless pseudarthrosis (Fig 9) At the end of this time he had a 1½ inch shortening and walked with a considerable limp in spite of a built-up shoe There was marked atrophy of the buttock, the thigh and the calf Flexion was 60 abduction and adduction were 5 and there was very little rotation.

On January 22, 1952, a Type 2 prosthesis was inserted through an approach resembling the Gibson, except that the trochanter was divided. A plaster boot with outrigger was worn for 3 weeks Considerable pain in the groin from stretched flexor and adductor muscles was relieved by Tolserol.

After the boot was removed the patient received 17 days of physical therapy during which time he improved rapidly He then was discharged bearing full weight. Length of the extremity was restored to within ½ inch

At 6 months the patient ambulated well without pain Motion had improved greatly flexion was 90 extension 10 abduction 10 adduction and internal rotation normal external rotation, 15 Working regularly as a business manager and ambulating about 3 hours per day he continued free of pain until 20 months after operation when while standing, he felt something give way in his hip This was followed by moderately severe pain and tenderness in the hip region. Push-pull roentgenograms revealed no looseness of the prosthesis. The pain subsided in 3 days, and the patient returned to full weight-bearing A similar episode of pain for 1 week occurred 30 months after o[illegible] after which he received exercises for gl[illegible] quadriceps atrophy

When last seen at 35 months, the pa[illegible] some pain that was accentuated by act[illegible] relieved by rest, but he did not have to [illegible] or crutches. Motion had improved fle[illegible] 100 , extension, 15 abduction 40 [illegible]tion 25 internal rotation, 30 exter[illegible]tion, 25 Push-pull films still showed [illegible] thesis to be seated securely and there [illegible] evidence of fatigue fractures of the nail[illegible]

This case illustrates good stability wi[illegible] 2 Atrophic muscles following fusion [illegible] habilitated with difficulty

Case 5 W D a white male 43 year[illegible] was admitted December 8 1952, diag[illegible] avascular necrosis of the right femor[illegible]

A Type 2 prosthesis was inserted [illegible] later through a modified Gibson appro[illegible] trochanter being reflected upward with [illegible] ductors intact (Fig 10 *top left*) The[illegible] then was kept in a plaster boot with o[illegible] for 2 weeks while the hip was maint[illegible] abduction Exercise in bed was beg[illegible] crutch walking at 3 weeks. He continu[illegible] exercises and use crutches until the eigh[illegible] and a cane until the twelfth. A cane t[illegible] carried for walking outside his home for [illegible] 2 months.

At 6 months the patient had no com[illegible] He walked a distance of several block[illegible] office and back daily and climbed stai[illegible] out pain using no external support Hi[illegible] of motion at this time was flexion 1[illegible] tension, 15 abduction 30° adductio[illegible] rotation not recorded. Roentgenograms [illegible] the prosthesis in good position, with no e[illegible] of loosening

The patient continued to be asympt[illegible] he was checked every 3 months. At 11 [illegible] after no sudden strain or onset of pa[illegible] roentgenogram showed that the superio[illegible] supplementary nail had fractured (Fig. [illegible] *center*) The anterior nail appeared fr[illegible] in the 13-month film. At 23 mont[illegible] superior nail had fractured in a second [illegible] In December 1954 2 years after inser[illegible] the prosthesis, the patient began to comp[illegible] pain and was given an injection of [illegible] cortone He continued weight-bearing [illegible] December 28 1954 had sudden onset o[illegible] severe pain. This apparently was due to [illegible] fracture of the inferior nail as shown in [illegible] 10 *bottom center* with obvious instab[illegible] the head.

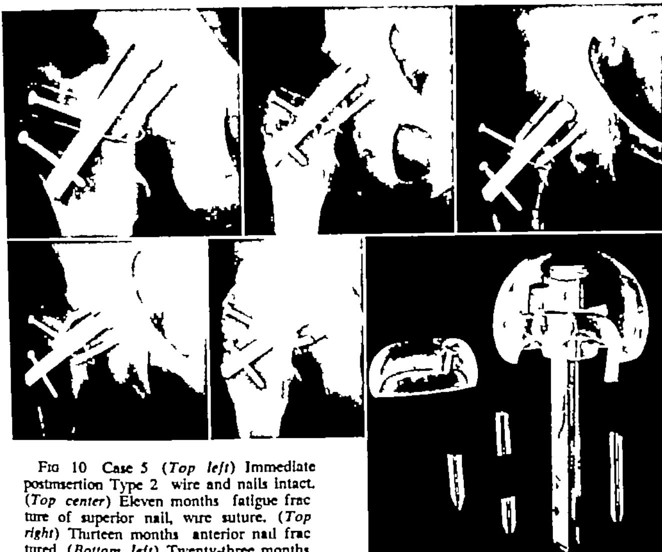


FIG 10 Case 5 (*Top left*) Immediate postinsertion Type 2 wire and nails intact. (*Top center*) Eleven months fatigue fracture of superior nail, wire suture. (*Top right*) Thirteen months anterior nail fractured. (*Bottom left*) Twenty-three months superior nail fractured at second point still no pain. (*Bottom center*) Twenty four months sudden onset of pain fracture inferior nail (and rim) with rocking. (*Bottom right*) Broken prosthesis removed.

On January 14 1955 the broken Type 2 prosthesis shown in Figure 10 *bottom right* was removed and replaced by a Type 3 The second postoperative course has been similar to the first. The patient has a full range of motion, i. e. flexion 135 extension 15 abduction, 30 adduction, 30 internal rotation, 60 external rotation 45 without pain The greater amount of internal rotation apparently is due to a prosthesis position of anteversion

This case illustrates the dependence of Type 2 on the supplementary nails for stability and why Type 1 failed.

Case 6 S R., a white male 47 years of age, was 1 of 3 bilateral cases He was active in sports, particularly basketball, for about 17 years, until 1943 when he developed pain and restricted motion in the left hip One year later similar symptoms began in the right hip The condition was diagnosed as arthritis and it progressed gradually until it was necessary to use canes (Fig. 11 *top left and right*)

On October 16 1950 a Smith Petersen cap was placed in the left hip For a while the patient was improved, but after 4 months he became worse than before and had to use crutches.

On admission, October 8 1951 in addition to requiring crutches he found it difficult to put on socks and shoes. Motion of the left hip was the more painful and showed flexion of 100 abduction of 30 adduction of 5 and no internal or external rotation. He was unable to raise the extended limb from the table. The right hip was less painful and stronger though it showed less range of motion, there being flexion of 90 abduction of 5 adduction of 20 and no internal or external rotation.

On October 15 1951 a Type 1 prosthesis was inserted in the left hip through a Smith-Petersen approach. The patient was held in a plaster boot with outrigger for 3 weeks. The pain had lessened so much following this procedure that he was anxious to have the second hip operated upon. Accordingly on December



FIG 11 Case 6 (*Top left and right*) Bilateral degenerative arthritis 5 years after onset. (*Bottom left*) Ten months postinsertion Type 1 left with rocking 8 months Type 2 right, stable (*Bottom right*) Immediate postreplacement Type 1 by Type 3

7 1951 a Type 2 prosthesis was placed in the right hip through a Hueter incision The limb then was suspended for 3 weeks and followed by exercise and crutch walking The patient left the hospital January 10 1952, on crutches to seek a warm dry climate

He was seen again on March 11 1952 when he complained of a slipping sensation in the left hip and some pain in both hips on full weight bearing He was placed at complete bed rest for 4 weeks, followed by exercise with considerable improvement. However in August 1952 he still complained of slipping and pain in the left hip and there was definite evidence that the prosthesis was rocking (Fig 11 *bottom left*) Therefore the Type 1 was replaced by Type 3 (Fig. 11 *bottom right*)

When seen the following year on November 4 1953 he reported that he had done well walking without crutches except during one brief period of pain On examination he walked with a waddling gait and used a cane to aid the left side where there was quadriceps atrophy as shown by 1-inch discrepancy in thigh circumference 4 inches above the patella Motion on the right was flexion 90 extension, 10 abduction, 45 adduction 45 internal rotation, 15 external rotation, 15 Motion on the left was flexion 90 extension, 10° internal and external rotation approximately 45 abduction and adduction, not recorded. There were pain and spasm of the left adductor muscles.

This patient was seen last on May 7 1954 29 months after insertion of the prosthesis on the right and 19 months after the second prosthesis on the left. He had become quite obese, and while he could walk with a cane, he had returned lately to using 2 crutches. Motion was slightly less. On the right it was flexion 70 extension 10 abduction, 45 adduction, 45 internal rotation 15 external rotation, 15 On the left it was flexion, 60 abduction and adduction, 45° no internal or external rotation Push-pull films revealed no subluxation or shift of the prosthesis. The patient was encouraged to lose weight and return to the use of a cane

This was the first patient in whom the Type



FIG. 12 Case 7 (*Left*) Untreated avascular necrosis 5 years with 20 adduction contracture (*Right*) Dislocation following insertion Type 3 without adductor tenotomy

3 prosthesis was inserted and it illustrates its use to replace Type 1 It also provides a comparison of all 3 types in which 2 and 3 appear to be equally effective

Case 7 R. E., a white male 31 years of age sustained a left femoral neck fracture in 1947 and was admitted December 19 1952, with avascular necrosis of the femoral head (Fig 12, *left*) He had been unable to work as a truck driver for 6 months because of severe aching pain Examination revealed 1½ inches of true shortening, but 3 to 4 inches of apparent shortening due to a 20 adduction and 15 flexion contracture Flexion was limited to 100 internal and external rotation to less than 5 All motion was painful. For 2 weeks he was treated with traction in an attempt to correct some of his deformity but without much effect. On January 21 1953 a Type 3 prosthesis was inserted by a Gibson approach

In retrospect, an adductor tenotomy should have been done at the time of insertion because the adductor contracture could not be corrected. The head was reduced with difficulty and before the patient arrived at his ward it had dislocated (Fig. 12, *right*) Skeletal traction of 20 pounds did not effect reduction Twelve days later he was returned to the operating room, where under anesthesia, strong traction and manipulation were applied on the fracture table but without success An open reduction then was performed and a hip spica was applied. Owing to severe pressure from the perineal post, a hematoma formed in the perineum and this was followed by an abscess, which drained for 4 days. Cultures revealed *Escherichia coli* The cast was removed at 6 weeks and exercises were begun Partial weight-bearing on crutches was begun 8 weeks after the initial operation and the patient was discharged at 11 weeks, bearing approximately half his weight on the affected extremity The



FIG. 13 (Case 7 *Cont*) Eighteen months after insertion bone formation about capsule fused clinically

TABLE 1 CASE MATERIAL

| Prosthesis Type | No. | Age (yrs.) | | | Follow-up (mos.) | | | | Diagnosis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Av | No. | Max. | Min. | Av | Avasc. Necr | Deg. Arth. | Rheum. Arth. | Other |
| 1 | 12 | 62 | 22 | 38 | 12 | 49 | 6 | 30 | 7 | 2 | 2 | 1 |
| 2 | 28 | 66 | 23 | 42 | 25 | 37 | 4 | 18 | 15 | 9 | 3 | 1† |
| 3 | 10 | 65 | 26 | 45 | 10 | 27 | 5 | 14 | 3 | 2 | 1 | 4‡ |
| Total | 50 | | | | 48 | | | | 25 | 13 | 6 | 6 |

* Defect from sequestrum.
† Undetermined.
‡ 1 bone cyst, 3 replacement Type 1

TABLE 2 RESULTS

| Prosthesis Type | Fate of Prosthesis | | | | Range of Motion | | | Pain | | | Ambulation Support | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unstable | Infec. | Broken | Removed | Incr | Decr | Unchg. | Incr | Decr | Unchg. | Crutch | Cane | None |
| 1 | 8 | 4 | 0 | 6 | 9 | 1 | 2 | 0 | 8 | 4 | 4 | 3 | 5 |
| 2 | 1 | 1 | 4 | 5 | 18 | 3 | 5 | 0 | 24 | 2 | 6 | 6 | 12 |
| 3 | 0 | 0 | 0 | 0 | 7 | 2 | 1 | 0 | 7 | 2 | 3 | 1 | 5 |
| Total | 9 | 5 | 4 | 11 | 34 | 6 | 8 | 0 | 40 | 8 | 13 | 11 | 22 |

In cases of breakage symptoms just prior are reported.

hip was checked at intervals of 3 months and was found to be doing well, with no severe pain At 9 months, flexion was 100 abduction, 30 adduction 35 and no internal or external rotation Marked crepitus was present on passive motion without pain There was ½ inch of shortening. Push-pull films revealed the prosthesis to be well situated in the acetabulum and seated securely in the femur Some bone had formed in the soft tissue superior to the greater trochanter

In spite of repeated advice to discard the crutches, the patient had continued to use them because of moderate pain when seen at 1 year Motion at this time was considerably less, there being flexion of 45 abduction of 10 adduction of 10 and no internal or external rotation. The bone formation in the soft tissue had increased considerably

At 18 months, the patient complained of less pain and walked at home without support. No hip motion could be detected clinically and the bone formation had increased further (Fig. 13)

This unusual result from myositis ossificans is attributed to the severe soft tissue trauma of the dislocation repeated manipulation and second operation. However in view of the protracted pain, spontaneous fusion may have been the best solution.

Details of case material and results are shown in Tables 1 and 2

## RESULTS

A total of 50 prostheses have been inserted into 47 hips of 44 patients In no case was there evidence of a reaction to the materials inserted. Type 1 was employed in 12 hips Eight of the 12 became loose Six of these have been removed Three in which there was no infection, have been replaced.

Infection has been a complicating factor in 5 hips In 1 the prosthesis was inserted deliberately in the face of known infection

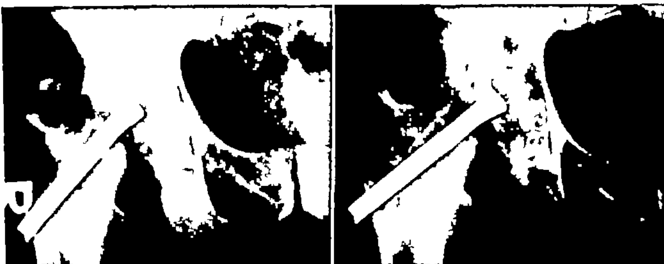


FIG. 14 Late displacement of prosthesis by trauma (*Left*) Unchanged by 2 years of painless ambulation (*Right*) Sudden onset of pain when helping to lift a 100-lb anvil shift in position not loose

as a temporary measure to maintain length Two patients developed infection as a flare up of previous infection Of these 1 had been quiescent for 1 year prior to surgery, the other for 2 years In the first the Type 1 prosthesis was found to be quite unstable at the time of arthrodesis In the second, the Type 2 continues to be stable but, owing to several flare ups it probably will be re moved A rheumatoid arthritic with post operative infection drained for 1 year After the prosthesis was removed there still was sufficient stability from scar tissue to give an excellent result. The fifth patient had a transient infection — discussed in Case 3 From this we would infer that removal of the prosthesis generally is necessary in cases of infection, but that arthrodesis is not always required.

Because of the high incidence of insta bility Type 1 was abandoned. Type 2 which then was used for all patients with sufficient length of the femoral neck, was inserted into 28 hips The stability provided was ex cellent, only 1 showed any looseness and that was of uncertain degree since it was removed in another institution. The difficulty encountered with this type was breakage of the nails through fatiguing of the metal. Re placement has been required in 5 patients, as illustrated in Case 5 These all were active individuals under 45 years of age with asymptomatic hips who were walking with out the use of cane or crutches and putting considerable strain on their prostheses The time lapse until breakage ranged from 16 to 24 months and it varied directly with the age and inversely with the activity of the patient. It is anticipated that in many of the older and less active patients prostheses will not break. However the rate of breakage was sufficiently high for us to abandon this type of prosthesis as not fulfilling requirement 5a page 72 The other requirements were met admirably by this prosthesis and the results were good up until sudden onset of pain when the prosthesis broke

The Type 3 has been used 3 times to re place Type 1 4 times for a short neck, once because of atrophic cancellous bone and twice since Type 2 was abandoned, or a total of 10 times It has proven to be a very satisfactory pattern. The resulting neck length is determined by the prosthesis rather than remaining bone thereby restoring proper mechanics Excellent fixation is provided by the curved stem and the long nail, which can snug to a stable position. While considerable cancellous bone is sacrificed, this is not considered to be too seri

ous since, in case of subsequent fusion, it can be replaced, and maximum cortical length is retained The theoretical "bursting barrel" fracture from the tapered stem has not been encountered in spite of full weight bearing as early as 6 weeks

The one anticipated difficulty with this prosthesis is in regard to requirement 5b page 72 and the material from which it is made i e, acrylic Four of the 6 Type 1 and 2 prostheses removed showed evidence of wear up to 1/16 inch in depth on the superior or weight bearing, surface of the prosthesis. The greatest wear was shown by a Type 1 which remained in the patient for 3 years. This patient also was of interest in that his prosthesis was displaced late by trauma since most loose prostheses developed within the first 6 months of full weight bearing. For the first 2 years he had no symptoms and there was no evidence of instability (Fig 14 *left*) Then he lifted 1 end of a 100-lb anvil and helped to carry it up a hill Following this he had continued pain and roentgenograms showed a shift of the prosthesis to a more varus position (Fig. 14 *right*) though push pull films revealed no rocking He continued in active employment and estimated that he walked about 3,500 miles during the 3 years

In view of this amount of wear it is estimated that in an active individual the prosthesis would become unserviceable in about 5 years from this factor alone A possible exception might be the patient in whom the acetabulum contained relatively normal cartilage offering less friction than a revised surface However to satisfy all requirements a more durable material is necessary

## SUMMARY

The ideal prosthesis (1) causes no tissue reaction (2) restores the normal mechanics, (3) is stable (4) conserves maximum of normal bone or ligamentous tissue and (5) will not, a break or b wear

Three experimental types of hip prosthesis are presented (1) an acrylic head on a trifin nail (2) similar to 1, plus 3 small peripheral trifin nails (3) a long tapered intramedullary form. A total of 50 have been employed clinically Requirements 1 2 and 4 were met by all types. Type 1 failed Requirement 3 Type 2, 5a, and all being made from acrylic, were deficient to some extent in 5b

## Acrylic Endoprostheses Coxal

*Summario in Interlingua*

Le substitution de un articulation artificial pro un articulation morbide o detrito es un desiderato urgente pro multe medicos e multe patientes Le prosthese ideal deberea satisfacer cinque requirimentos (1) Illo non debe causar historeactiones (2) Illo debe restaurar le mechanica normal. (3) Illo debe esser stabile (4) Illo debe conservar un quantitate maximal del substantia ossee (5) Illo debe ni franger se ni abrader se

Esseva usate tres typos de prosthese Typo I—capite acrylic super un clavo tri-alate. Typo II—simile a I con le addition de tres tri-alate clavettos supplementari Typo III—capite acrylic con pediculo fusiforme curvate super un longe clavo intramedullar

Typo I esseva abandonate post uso in 12 patientes proque in 8 casos illo perdeva su stabilitate In 6 casos illo esseva removite. In 3 casos illo esseva reimplaciate. Le resultatos esseva bon quando illo reteneva su stabilitate sed le violationes del requirimento 3 esseva nimis numerose

Typo II esseva inserite in 28 coxas. Omnes, con un sol exception remaneva stabile Quatro se frangeva in consequentia de fatiga del clavo Istos esseva reimplaciate Le resultatos essev bon usque al tempore del fractura que violava le requirimento 5

Typo III esseva usate in 9 coxas Omnes ha remanite stabile Nulle fractura de femore o prosthese ha occurrite

Le prostheses que esseva removite exhibiva

signos de detrition al superficie superior Le detrition maximal amontante a circa 2 mm esseva trovate in un prosthese que habeva essite in uso active durante tres annos Viste iste grado de detrition in plastico acrylic, iste material non pote esser considerate como le material le plus satisfacente pro le superficie de articulationes prosthetic

Section II

# GENERAL ORTHOPAEDICS

11

# Reconstructive Surgery in the Paraplegic Patient with Decubitus Ulcers*

N. Georgiade, M.D., F. Masters, M.D., C. Maguire, M.D. and K. Pickrell, M.D.

Modern therapy and rehabilitation of the paraplegic patient demand a "team approach," which includes the services of many specialists in diversified fields. The major role of the plastic surgeon is in the treatment of a complication of paraplegia, the decubitus ulcer. This ulcer, better known perhaps as a "pressure or bed sore," is preventable and often is the direct result of ignorance, inadequate nursing care and lack of necessary physical and educational facilities. The best treatment is prophylaxis, for when established the surgical correction is difficult and time consuming, and the total rehabilitation process may be delayed for weeks or even months.

## DECUBITIS ULCERS

Etiology. Physiologically a decubitus ulcer is the result of prolonged pressure over one or more of the bony prominences such as the sacrum, the trochanters or the ischial tuberosities.[4] In the paraplegic the natural body defenses against ulceration are destroyed, cutaneous sensation is absent, and there is virtually complete loss of vascular and muscle tone. Prolonged pressure over a bony prominence will destroy the protective subcutaneous fat pad. If it is allowed to continue, pressure will devitalize the overlying skin by thrombosing its vascular supply. Ulceration then is inevitable. Unfortunately, since the pathologic process begins in the subcutaneous fat, the surface manifestations of a decubitus ulcer are not a reliable index of the actual involvement. Like an iceberg, the pressure sore is much more extensive beneath the skin than is apparent on the surface (Fig. 1, *top*). It is this phenomenon that may account for some of the early failures in treatment.

Infection of the already traumatized soft tissues slows or prevents healing and leads to further tissue destruction. As the ulcer enlarges, the deeper structures are involved, and it is not unusual to see bony prominences completely bared (Fig. 1, *top*). Osteomyelitis of the underlying bony prominences is a frequent complication, and a large local or distant abscess hidden by lack of sensation may lead to undiagnosed toxemia, progressive debilitation and death.

Location. Decubitus ulcers may occur wherever prolonged pressure exists; however, the bony prominences of the pelvis are the most common sites. Prior to the innovation of the "team approach" to the treatment of paraplegia, decubitus ulcers appeared most commonly over the convexity of the sacrum, the anterior iliac spine and over the greater trochanters of the femur. In recent years, as the rehabilitation program succeeded in restoring many patients to a sitting position,

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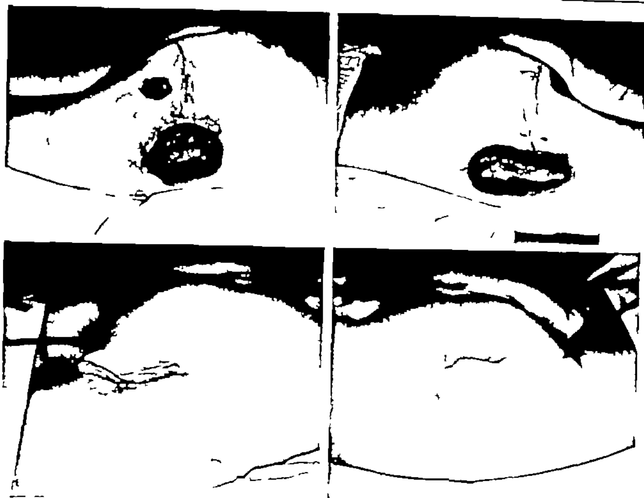


FIG 1 (*Top*) The large trochanteric ulcers are deeply undermined with exposure of the greater trochanter of the femur (*Bottom*) The previously transferred flaps are healed completely The donor flap areas have been resurfaced with split thickness skin grafts

common pressure points have shifted from *the trochanter and the sacrum to the ischial* tuberosities (Figs 4 *left* and 5 *left*) The ischial ulcer usually is small but deep and osteomyelitis of the ischial tuberosity is common This decubitus, however is more amenable to treatment than that over the sacrum or the trochanters

**Treatment.** The treatment of the established decubitus ulcer is surgical.[7,8,1] The ultimate aims of surgical therapy are not only to heal the present ulcer but to prevent its recurrence so that the paraplegic may continue along the road to rehabilitation

The ulcers and the offending bony prominences must be removed surgically The trochanters the ischial tuberosities and the sacral and the anterior iliac spines are sacrificed to correct the physical cause of the ulceration. When these prominences are removed, a protective padding of skin and subcutaneous fat in the form of a pedicle flap is transferred to resurface the surgical defect.[3,8,10] This gives additional protection against recurrence The protective pad used to resurface a pressure point always is borrowed from an area not subject to pressure (Figs. 1 *bottom* 2, *bottom* 3 *right* 4 *right* 5 *right*) The surgical correction of such ulcers *is a major undertaking, and frequently it* must be performed in stages

## TROCHANTERIC ULCERS

A wide excision is performed round the ulcerated area including the undermined areas down to the trochanter It is necessary at this point to remove a portion of the pro-

ing the denuded area All sharp points must be leveled to form a wide flat, smooth base and then an adjacent flap is transferred to cover the defect (Fig 3) In many cases it is necessary to transfer a large flap th crosses the mid line In these instances, or 2 delays of the flap are necessary prior t transfer The denuded area always is planne



Fig. 4 (*Left*) The area of greatest pressure over the ischial region is outlined sharply (*Right*) Large gluteal flaps have been rotated inferiorly to resurface the pressure areas following bilateral ischiectomies. The drains always are placed in the most lateral position



Fig. 5 (*Left*) This large extensively undermined ischial ulcer must be excised widely prior to reconstructive surgery (*Right*) A lateral thigh flap was utilized in covering the large ischial defect which resulted from wide excision of the decubitus ulcer and ischiectomy The split thickness skin graft is in an area not normally subjected to any pressure

so that the subsequent area to be resurfaced with a split graft is not itself in a pressure area

## ISCHIAL ULCERS

If only a superficial ulceration is present over the ischial tuberosity the scarring and the ulceration can be excised, and at the same time a portion of the superior and medial aspect of the ischial bone can be removed and the defect closed primarily Penrose type drains are placed at the lateral aspects of the operative areas and are removed gradually over a period of 3 to 4 days. (Fig 4) The best results in our series and others[1 5 7] were obtained when a complete ischial tuberosity ostectomy was performed through the obturator foramen Pressure thus is distributed over a wide flat base with little or no pelvic instability In the more extensive ischial ulcers, adjacent flaps are transferred to cover the surgically débrided area (Fig. 5)

## PREVENTION

Education of the patient must be continuous and repetitive in order to prevent further pressure sores The following points are stressed to both the patient and those intimately concerned with his welfare

Turning The necessity for routine and regular turning to avoid prolonged pressure over a bony prominence is of utmost importance A paraplegic must be turned often enough to prevent skin irritation. The patient himself must be educated in the value of moving, and, if possible taught to turn himself, usually every 2 or 3 hours

Padding Whether the patient is bedridden or has graduated to a wheel-chair existence the lesser bony prominences such as the knees and the heels must be protected also While in bed, a pillow between the knees and the ankles acts as a pad, and when in a wheel chair the popliteal areas and the heels must be protected from the seat and the foot rest. The use of rubber rings and "doughnuts" is mentioned only to be condemned These time honored devices, used primarily to protect an area of incipient ulceration do not accomplish their objective While weight is taken directly off a bony prominence, it is not distributed generally over the body area but instead is concentrated in a circular area immediately surrounding the newly formed ulcer This causes pressure round the involved area interferes mechanically with cutaneous circulation and eventually leads to ulceration over a more extensive area rather than preventing it.

While in bed, paraplegics should be placed on a sponge rubber mattress to distribute their weight more evenly Sheets and other bedding underneath must be flat and without wrinkles If the turning regimen is followed it will give adequate protection against prolonged pressure over any individual bony prominence

Diet. The paraplegic, particularly with decubitus ulcers often will have a disturbance in protein metabolism Healing depends upon an adequate dietary intake All paraplegic patients should receive a diet high in protein and vitamins[11] In a majority of paraplegic patients frequent whole-blood transfusions are necessary preoperatively Testosterone propionate originally was recommended by Langston[9] in the chronically debilitated patient with decubitus ulcers It has been found to be of value particularly in our older patients.

Urinary Tract Infections. Preoperatively the paraplegic is evaluated *completely* from a urologic standpoint. Indwelling catheters are maintained in position during the period of reconstructive surgery and suitable antibiotics are administered.

## SUMMARY AND CONCLUSIONS

The need for proper education of the patient and those responsible for his care has been stressed Reconstructive surgery technics of the more common areas of decubitus ulcers have been discussed. Prophylactic ischiectomies have been found to be of value in patients rehabilitated to the wheel chair

12

# Growth Acceleration in Legg-Calvé-Perthes' Syndrome by Complementary Feedings of Aureomycin[13*]

CHARLES W GOFF, M D

Growth is decelerated commonly in many diseases and disorders of children and young people Nutritive factors of diet are well-known decelerators if they are in short supply[4 6,10 14 16,27 29] Other noxious influences operate within the child's environment,[26 42] any or all of which may contribute to a slowing down of growth Genetically some children grow late

Growth is measurable by a number of dimensions that are obtained easily[7,9 11 13 16 17,23,33,38,41] These can be correlated with a recognized sample of the population that seems to fit the group of children composing the project under study[14 16,24 34] If the sample is large statistical methods of correlation are profitable If the group is small each child may be compared on an individual basis with a selective control[5]

Antibiotics have been added to the diet of children, particularly in underprivileged areas[1 6,27] with and without vitamin $B_{12}$[42] in various combinations Preliminary reports point favorably toward growth acceleration in these large group studies. The measure of increased growth has been moderate and controls somewhat difficult to establish adequately Nevertheless a stimulation of statural and ponderal increments seems to follow complemental feedings of antibiotics The animal protein factor is said to be involved. These studies together with comparable reports of growth accelerations in the animal-food raising industry[2] prompted the use of Aureomycin as an addition to the diets of children with a known growth delay associated with an avascular necrosis of the capital femoral epiphysis (Legg-Calvé-Perthes syndrome) and related true osteochondroses of other growth centers[18]

Often simple growth deceleration is insidious, the result of many subtle and, frequently latent factors The terms *lowered physique* and *lessened physical vigor* have been used to indicate such a slowdown. In children with Legg-Calvé-Perthes syndrome there was no lessening in physical vigor on the contrary they were rated as hypertonic, very active alert, and usually "up to snuff" However they were considered below par in growth relations compared with their brothers and sisters at similar ages Parents rated them as "something less shorties" or "just not growing as well"[13]

## MATERIAL

During the past 5 years 60 children have been under treatment for these disorders in Newington Home and Hospital for Crippled Children Of these 15 were fed Aureomycin together with 10 additional children from

* Read at the annual meeting of the Association of Bone and Joint Surgeons held in Augusta, Georgia, April, 1954

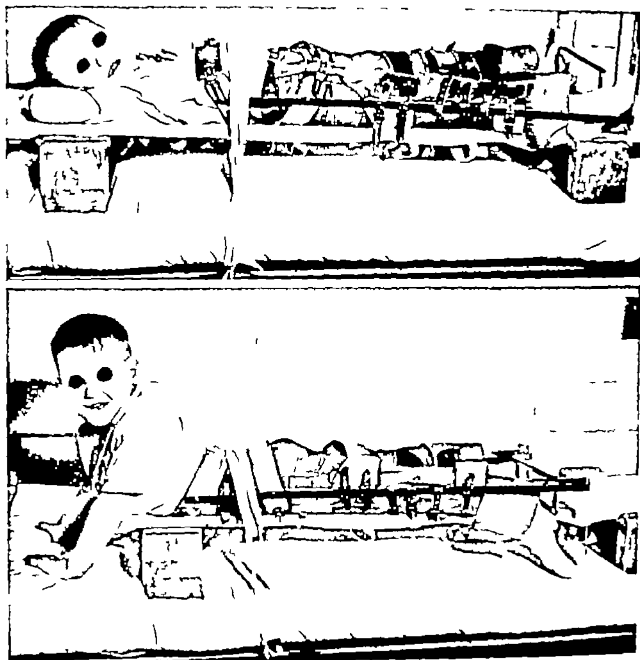


FIG 1 Standard recumbent iron frame, resting on a Bradford frame elevated by blocks on a hard mattress.

the author's private practice All were maintained on an excellent, rounded diet of 2,500 calories per day fortified by vitamin feedings, including $B_{12}$ All have been treated by recumbency [8, 11] a nonpermissive weight bearing frame being used. Active and passive exercises are accomplished daily under skilled guidance All 25 still are under observation and some continue to receive the minimal daily Aureomycin dietary additive Parents are enthusiastic proponents, their children seeming to them to be in better general health irrespective of the age and the stage of the disorder The results are reported.

## CONTROLS

These were selected from children with the same disorder under treatment of exactly the same character but without the complementary antibiotic feedings - These control children manifested their individual

patterns of growth as would be expected Cases were matched for age sex and stage of the avascular necrosis as determined by roentgenogram This method proved to be difficult because of the well known irregularity of reossification of the growth center However no better control method seemed possible of achievement

## TEETH

Tooth age was well correlated with bone age in both deceleration and acceleration [7,12,20]

## METHOD

In addition to many growth measurements, bone maturation or bone age was determined at regular intervals together with constitutional appraisals [9,11,13,17] Roentgen progress of the bone lesion was followed carefully The growing rate prior to onset of disorder usually was not determinable with any objectivity other than by a history analysis given by parents The usual family and pediatrician records were not helpful A few were seen 1 year to a few months prior to positive roentgen findings All were deceler

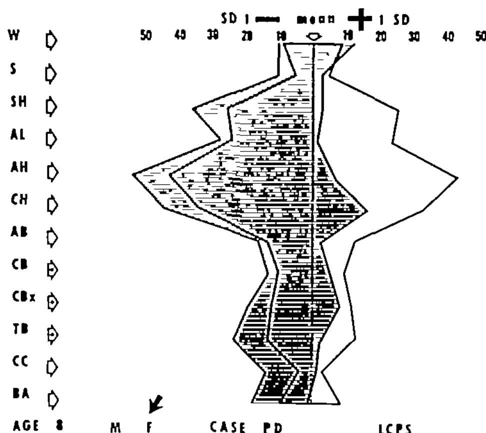
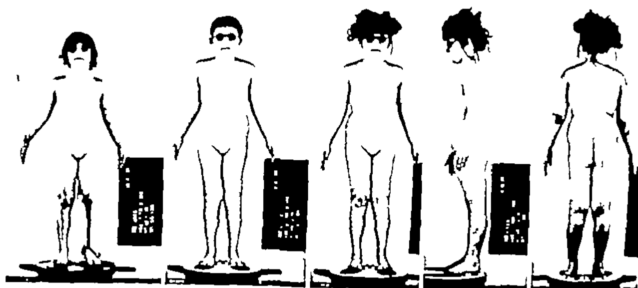



FIG 2 Standard deviation graph of growth. (W) Weight in pounds. (S) Stature in cm. (SH) Sitting height in mm. (AL) Arm length. (AH) Acromial height (CH) Cristal height. (AB) Acromial breadth. (CB) Chest breadth (CBx) Cristal breadth (TB) Trochanteric breadth. (CC) Chest circumference in cm (BA) Bone age in months

The shaded area indicates start to finish of growth dimensions during 12 months of Aureomycin feedings from 7 years and 6 months to 8 years and 6 months of age The child still is short of her mean growth range but she has accelerated beyond her expected rate during these 12 months. This time interval also is indicated in Figure 3 by the 2 arrows and the double lines near the bottom of the chart. Proportional growth, when of use in a child's study may be plotted readily as in this standard deviation graph.



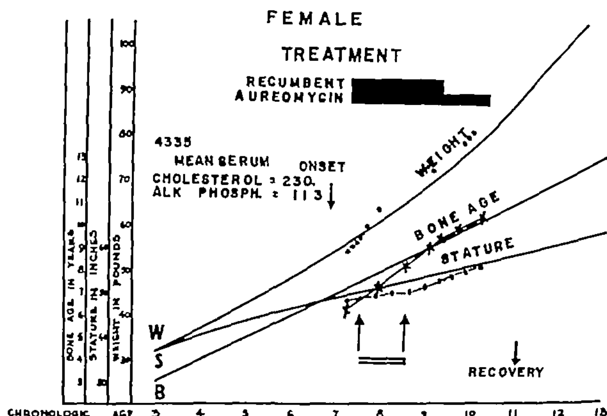



FIG. 3 Female 4335 Onset age 7 years. Rapid degeneration of epiphysis. Recumbent 24 months with slowest reossification. Weight-bearing on crutches for 6 additional months and Aureomycin for 38 months. Longest and slowest case Constitutional type the heaviest = 5 4 2. Result poor judging by incomplete restoration of spheroidal head later plates show a rapid reossification. *The 2 arrows with double lines beneath them on* graph represent the period portrayed in Figure 2. Note the disproportional weight, circumferences and cristal height (CH) increase

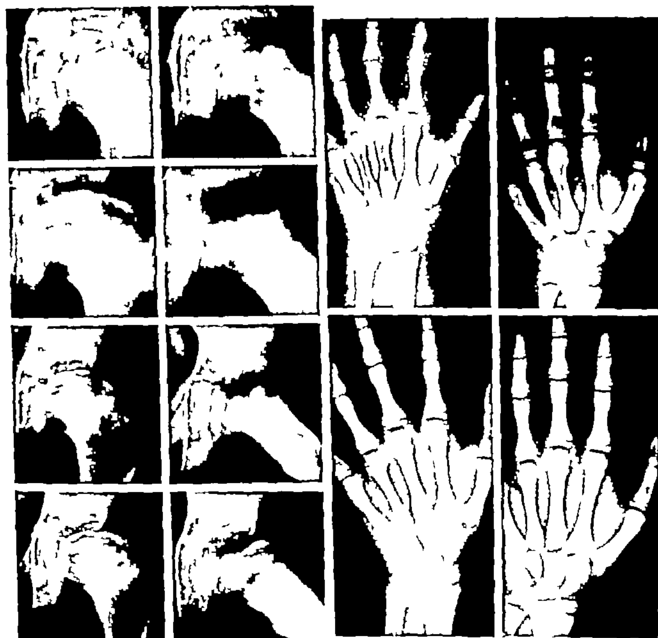


FIG 4 Female 4335 Roentgen progress of LCPS and bone age maturation plates These latter indicate a mean age restored in 22 months after beginning Aureomycin feedings

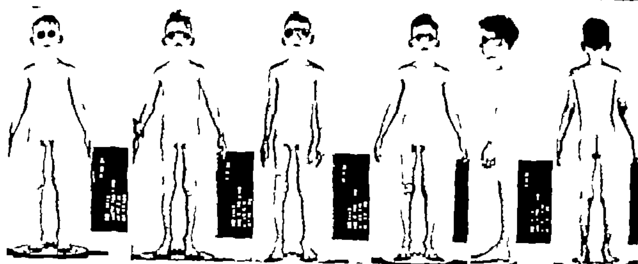
ated in general growth about 10 per cent for age

No physical performance tests[38 41] were given these children, and no basal metabolic levels were determined. The methods available were considered to be too labile and not accurate[4] Serum cholesterol and alkaline phosphatase determinations were measured regularly These were equivocal hence not significant. Each child demonstrated a personalized level and seemed to maintain his or her level during observation periods

Recently radioactive isotope iodine[13] has been used by some investigators to determine the B.M R. This is promising, varying from 14 to 39 per cent uptake in 24 hours The few that have been done in this series are not significant, except to suggest a low normal rate

## ANALYSES

Such a study lends itself to graphic analyses that can be complicated A single example will be sufficient to indicate the type



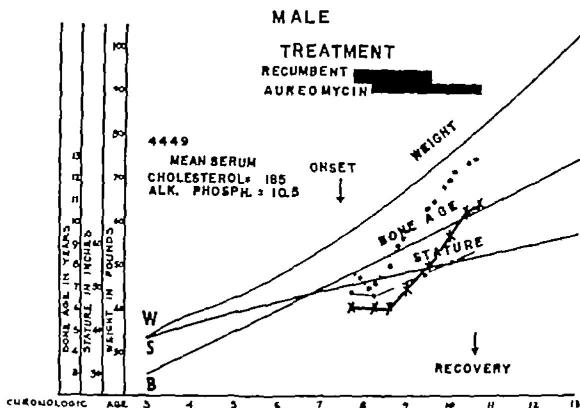



FIG. 5 Male 4449 Onset age 7 years and 7 months. Extensive and rapid degeneration of epiphysis. Recumbent 21 months with an average speed of reossification. Aureomycin was started 5 months after onset with the least statural stimulation of the series and a slow start toward mean bone age The patient seemed to lose ground consistently during the first 9 months Recovery after 30 months. Constitutional type the most linear = 2 3 5 Result probably will be good to be judged at end of 5 years from onset.

of graph used This was suggested by Krogman, [4] and it is defined as the standard deviation (SD) chart To the left of the line "m" or median value are those dimensions of −1 or more SD and to the right are those of +1 or more SD The pattern plotted by a heavier line equals 1 standard deviation allowing a rapid impression of the child's growth at the age given Each age over a 12 month span has its own pattern Another method of plotting progressive values perhaps shows more quickly the course of the

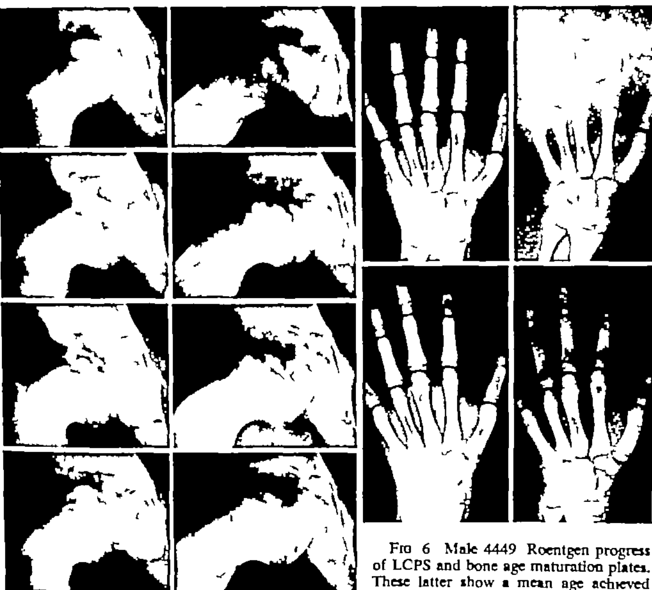


Fig 6 Male 4449 Roentgen progress of LCPS and bone age maturation plates. These latter show a mean age achieved after 30 months of Aureomycin feedings.

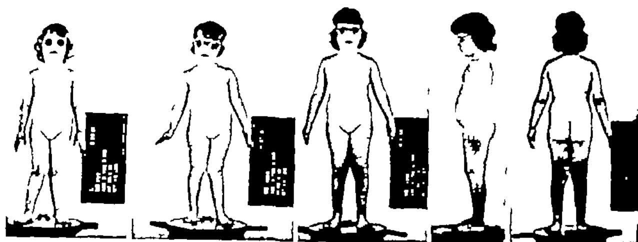
test cases These are simple charts 4 examples of which will illustrate the information obtained. Normal or mean values were drawn from Gray[10] and Simmons[34] whose community samples seemed to conform with the Connecticut population as to economic status nutritional level and other environmental and genetic qualities

## DISCUSSION

These children, given Aureomycin feedings, were between 3 years and 10 years +6 months of age All were seen before the onset or within a few months of the onset of their hip disorder All demonstrated 1 5 to 5 standard deviations in growth deceleration at their respective ages. Their bone ages were all 1 7 to 5 0 standard deviations below their age means

Two children (1 male 1 female) were given Aureomycin, 250 mg. with their breakfast for 14 months This then was cut to 50 mg. when the smaller dose was found to be sufficient. These 2 children increased in stature and weight more than the other 23 children The female gained 2 7 inches and 28 pounds respectively during that period (14 months) surpassing her mean for age by 30 per cent. It should be remembered that she was decelerating prior to feedings

The remaining 23 children were given 50 mg of Aureomycin by mouth with their breakfast for varying periods of 8 to 36 months. Each showed an acceleration in



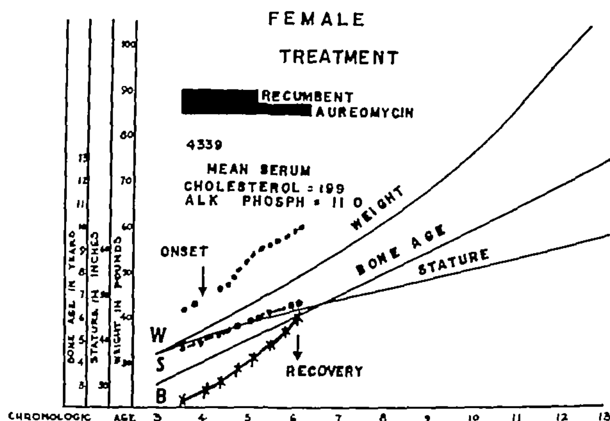



FIG 7 Female 4339 Onset age 3 years and 6 months The patient was seen 6 months prior to onset, and treatment was started immediately on appearance of acute synovitis and prior to any roentgen findings The LCPS was practically aborted with recumbency and Aureomycin from the first day Recumbent 17 months. Aureomycin feedings 32 months Statural changes minimal but weight excessive. Recovery after 24 months but Aureomycin was continued because bone age had not returned to mean age

weight and stature Their bone ages all re turned to their mean level They responded in this respect as did those children with a hypothyroidism not cretinism reported by several investigators[4 2"] when fed thyroid ex tract daily The roentgen indications of their hip disorders followed in trace with their growth increments, particularly their return to a normal bone age The avascular necrosis passed through its stages toward reossifica

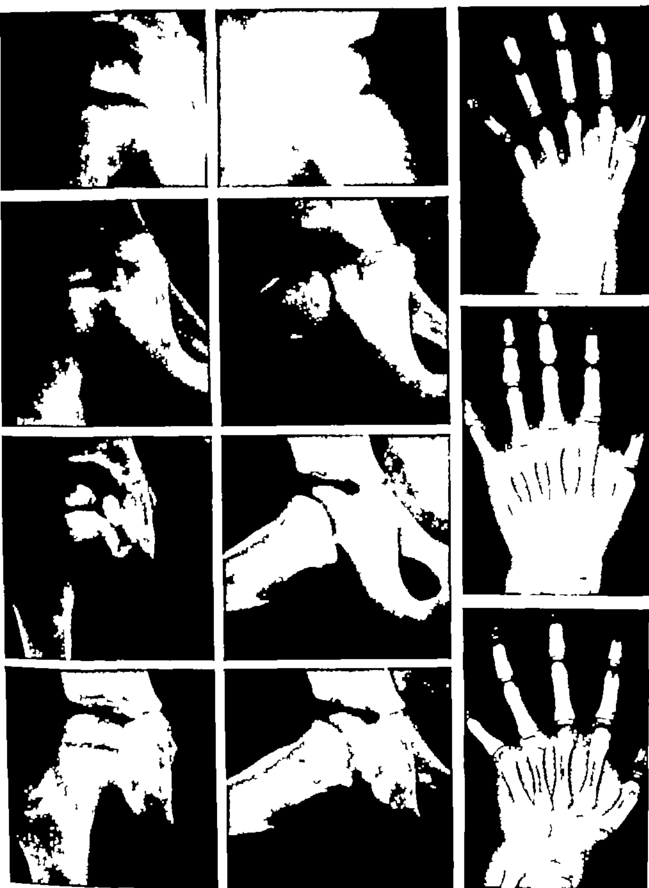
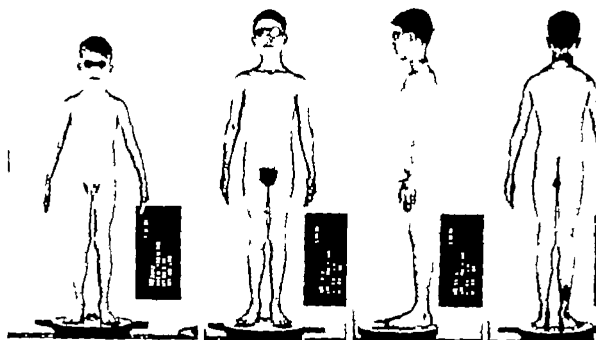


FIG 8 Female 4339 Roentgen progress of LCPS and bone age maturation plates. A typical return to mean determinations Aureomycin was continued until mean bone age was achieved. There will be an excellent end-result, Type 1 spheroidal.[13]



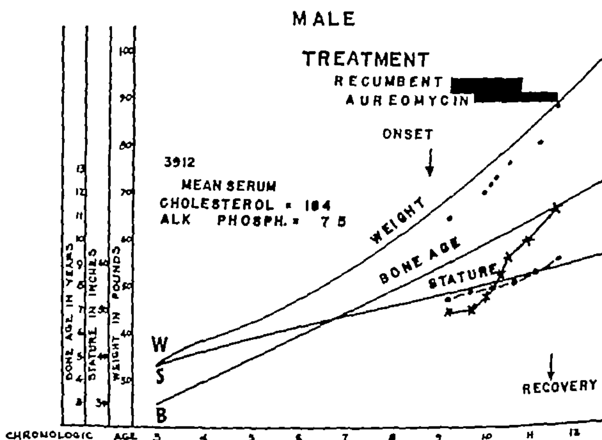



FIG 9 Male 3912. Onset age 8 years and 11 months. Rather localized involvement of epiphysis. Recumbent 18 months. Aureomycin feedings began 6 months after onset stimulation of stature was not remarkable but bone age began to climb toward the mean very soon afterward. Recovery after 28 months

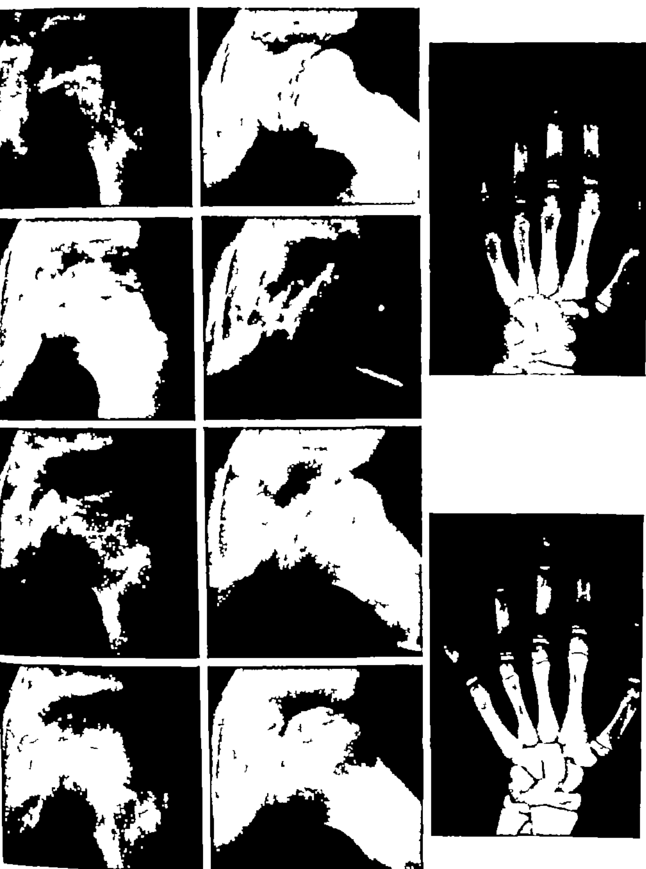


FIG 10 Male 3912. Roentgen progress of LCPS and bone age maturation plates Aureomycin was continued until the latter was up to mean for age, 28 months after onset and 21 months of Aureomycin feedings There will be a good end-result, Type 2, spheroidal.[13]

tion at an accelerated rate All controls demonstrated less acceleration, although all returned to a mean bone age equal to their chronologic age with roentgen evidence of reossification of the growth nucleus prolonged by approximately 12 months Thus the acceleration, apparently due to Aureomycin or some by product of its administration, was

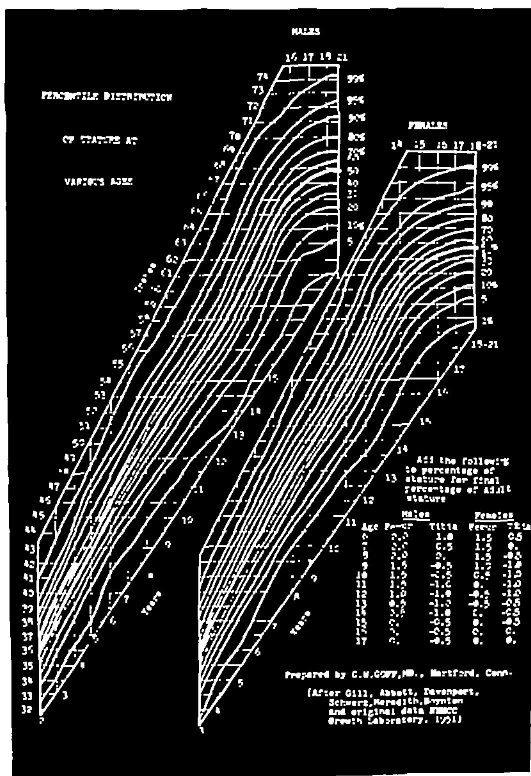



Fig 11 Percentile distribution chart for stature—male and female The channels are very useful for noting progress. All values corrected for popula tion in Connecticut

rated as 25 to 30 per cent for the series studied As has been mentioned, this is a small group but Legg-Calvé-Perthes Syn drome in numbers is hard to come by and it is even more difficult to find a like number for controls It is exceedingly difficult to evaluate correlations of a clinical character In this instance only a pilot investigation is intended It is hoped that others will use the substance which, at any rate has proven to be completely harmless It was not intended that the use of Aureomycin would control any possible infection lurking within the child—surely not within the hip structures

## COMPLICATIONS OF THERAPY

To date this minimal dose of Aureomycin has not given rise to any complications They have been expected warnings have appeared in a number of published reports[3,10,21 22] [illegible] The difficulties inherent in cultur ing stools and identifying the fungus forms were discussed with responsible co-workers It was decided to await clinical evidence of the disorder Such evidence was completely absent.

## MECHANISM OF GROWTH STIMULATION

Neither an antithyroidal[26] nor a thyroidal or other hormonal mechanism[30] has been proven to be operating to date In the mod erate degree permissible in these children with decelerated growth and an osteochon drosis, too many variables exist. Clinical studies of this nature correlate poorly Per haps an adrenocorticohormonal reaction takes place during the use of terramycin and streptomycin,[29] as some investigators have reported.

## CONCLUSIONS

From these 25 children studied, it seems that a minimal complementary feeding of Aureomycin 50 mg daily will accelerate growth appreciably (probably 30 per cent) and by doing so that it will accelerate the reossification of their capital femoral epiphyses or other growth centers when they are involved Perhaps other diseases, with long recovery periods accompanied by de celeration of growth may respond in a like manner, shortening hospitalization and has tening recovery The surface has been barely scratched relative to potentials of these fas cinating products

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## Acceleration del Crescentia in le Syndrome de Legg-Calvé Perthes per Medio del Alimentation Complementari de Aureomycina

*Summario in Interlingua*

Antibioticos ha stimulate le crescentia in le industria del elevage de animales alimentari Proque le syndrome de Legg-Calvé-Perthes monstra como un de su complexe correlationes un considerabile deceleration del crescentia, doses diurne de 50 mg de aureomycina esseva administrate a un serie de 25 patientes durante periodos de 30 menses o plus Le effecto esseva un stimulation del crescentia manifeste specialmente in le etate ossee con un augmento de circa 30 pro cento in comparation con seligite casos de controlo Isto representava un reduction del tempore de recuperation per inter 8 e 12 menses Le convalescentia esseva correspondentemente abbreviate Nulle complicationes esseva incontrate

# 13

# Fatigue Fracture of the Fifth Lumbar Neural Arch

## Is Spondylolysis a Stress Fracture?

LEE A HADLEY M D *

Spontaneous "fatigue" fracture of healthy bone occurs as a result of repeated stress applied beyond the capacity of the structure to withstand injury These insufficiency fractures occurred in large numbers among our recruit troops in the last war but for long they had been recognized in the armies of Continental Europe Described as "march fracture " usually they involved the shafts of the second, the third or even the fourth metatarsals Next in frequency was the tibia, with 11 per cent, followed in turn by the femur the fibula the os calcis and, finally the ischial and the pubic arches

After prolonged periods of stress these fractures develop first as a small subperiosteal infraction of the cortex Later this may extend finally to encircle the entire shaft and appear as a fine hair line fracture The location of these fatigue fractures seems to correspond to the points of greatest stress By spectroradiographic studies, definite molecular changes in the bone have been demonstrated at these points Hartley states that "bone exhaustion occurs when these [changes] have proceeded beyond the point of normal repair " When healing becomes established the fatigue fracture is indicated by a well-developed bony callus.

Because there has been some confusion it should be mentioned that evidence of injury develops likewise at points of stress in certain types of pathologic bone (osteomalacia and other diseases) Because of the systemic disease these defects usually are symmetrical—the so-called milkman's fracture They appear as bands of radiolucency crossing the bone the Umbauzonen (transformation zones) of Looser These persistent zones of decalcification are composed of vascular osteoid tissue They do not develop ordinary callus formation because of the underlying disturbance in calcium phosphorus metabolism However because of a comparable etiology they have been confused with the insufficiency stress fractures occurring in healthy bone A proper term for them is pseudofracture as contrasted with the stress or fatigue fracture seen in normal bone

Few examples of fatigue fracture involving the spine have been mentioned Hartley has reported as stress fracture the case of a 17 year-old boy who carried 100-lb bags of coal between the shoulders for a period of months First he felt a "throb" behind the sternum while at work Later and without any violence there was a sudden collapse with acute dorsal pain of a "tearing" nature and the patient could not sit up Roentgenograms showed a collapsed wedge shaped D5 vertebra with clean outlines There was no pathologic change in the neighboring vertebrae Hartley considered

* Syracuse New York.

this to be a fatigue fracture in a structure that had been subjected to excessive weight bearing stress.

The following case presents certain features of stress fracture involving the left fifth lumbar pedicle

A 19 year-old male without history of any accident complained of gradually increasing pain in the lower back. Radiographs of the fifth lumbar arch showed a break in the continuity of the pars interarticularis on the right side but not on the left. The left pedicle showed a fracture line and appeared quite dense as compared with its fellow on the right. Subsequent examination 5 years later showed complete healing of the fracture of the left pedicle

One can postulate that an asymmetrical unbalanced stress on the pedicle of the left side resulted from the deficiency of the right pars interarticularis Given this condition in a young laboring man, the development of a fatigue fracture of the pedicle would seem to be possible (Figs 1 3)

Certain writers[3 9] have suggested that the defect in the neural arch in cases of spondylolysis may be identical with stress fractures elsewhere The pars interarticularis, where these defects occur, is the most slender portion of the arch. Also shearing stresses at the lumbosacral level are incidental to the upright position That most of these do not show bony union is compatible with Rous's law which states in part that a fracture subjected to shearing stress during healing will heal by fibrous union Attempts at bony union probably do occur in certain cases. Schmorl has shown an example of fusiform bony callus bridging the neural arch break in a 68 year-old male cadaver with spondylolisthesis

Of some interest in this connection is a group of private patients with spondylolysis showing calluslike bony masses projecting into the spinal canal at the site of the arch defect Bony hyperplasia or separate ossicles

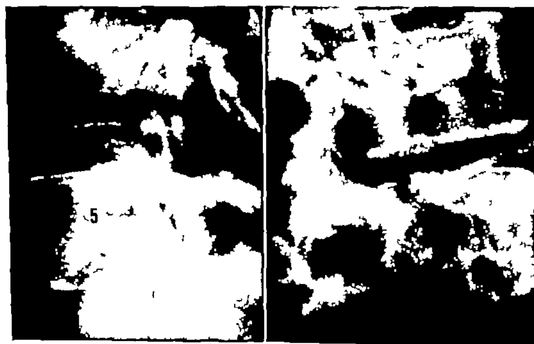



FIG 1 (*Left*) Left oblique roentgenogram. No spondylolysis of the L5 isthmus. Note distance between the fourth and the fifth posterior articulations and the position of the fifth directly beneath the fourth, though slightly more horizontal. (*Right*) Right oblique Spondylolysis of the fifth neural arch (arrow) The fourth and the fifth articulations are approximated and the plane of the fifth is posterior to that of the fourth as compared with the condition on the left side.

at the site of the arch defect have been encountered at operation and in the anatomic studies

With the paucity of actual proof for the congenital origin of L5 arch deficiency is it not possible that this common condition may be in certain cases at least a stress fracture?

The author is indebted to the Photographic Department of the New York State School of Medicine at Syracuse for assistance in preparing the illustrations

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FIG. 2 *(Left)* Lateral view at 19 years of age. Fracture line through the left fifth pedicle with bony hyperplasia (arrow) No spondylolisthesis. *(Right)* Lateral view at 24 years of age. Fracture healed in 5 years Transitional first sacral segment (S) There is bony encroachment of the fourth intervertebral foramen

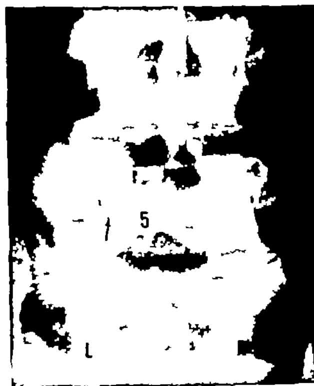



*FIG 3 Postero-anterior* view showing increased density of the left fifth pedicle and some bulging of bony tissue into the spinal canal (arrow) Compare with pedicle on the right side. Fifth spinous process displaced to the left (5) Transitional first sacral segment.

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## Fracturas de Fatiga in le Arco Neural del Quinte Vertebra Lumbar

*Summario in Interlingua*

Fracturas a insufficientia spontanee oc curre frequentemente in ossos normal a punctos subjicite a recurrente stresses que excede le fortia de resistentia del structura in question On ha speculate que le defecto del arco neural in casos de spondylolyse es possibilemente un tal fractura de fatiga Le parte interarticular in que iste defectos oc curre es le portion le plus tenue del arco Stresses tangential que pote prevenir le cura tion, occurre al nivello lumbo-sacral in con sequentia del postura erecte

Un masculo de 19 annos de etate con un deficientia in le quinte isthmo lumbar al latere dextere disveloppava sin accidente un fractura in le pediculo sinistre Un re examine cinque annos plus tarde revelava un curation complete Il non existe genum provas pro le origine congenite del frequente deficientia del arco $L_5$ De facto il existe indicios a provar que illo non es congenite Le question se presenta si alicunes de iste casos non es possibilemente le resultato de fracturas sub stress

# 14

# Treatment of Intertrochanteric Fractures in the Severely Debilitated Patient

HERBERT E HIPPS M D *

The purpose of this chapter is the presentation of a satisfactory method of treating intertrochanteric fractures in those of the old-age group who are too severely debilitated to undergo a major surgical procedure such as an open reduction and insertion of an internal fixation device

In this method of treatment, a modified well leg traction splint is used I will present the details of the technic of reduction the use of the splint, and in particular the proper after-care which is extremely important in preventing complications

The old time conservative treatment of intertrochanteric fractures in the aged that necessitated prolonged bed rest had too high a mortality and morbidity rate and the hospital stay was entirely too long A review of recent literature on this subject found the mortality rate to vary from 44 per cent to 20 per cent and the complications during treatment were many and severe The average hospital stay in this group was 78 days

With the advent of surgical correction and the application of an internal fixation device the over-all mortality rate dropped to an average of 12 4 per cent The complications diminished markedly in number and degree and the hospital stay dropped to an average of 23 days However this mortality rate still is too high largely because of deaths occurring during and soon after surgery The surgical mortality rate (deaths during or soon after surgery and directly attributable to the surgical procedure) as obtained from a 10-year review of American literature varies from 39 per cent to nil and the average is 11 7 per cent. Furthermore the surgical implantation of an internal fixation device is not entirely free from complications which when they occur lead to a poor end result.

The following complications occurring after surgical correction have been noted from the literature surgical shock cardiac failure auricular fibrillation, excess anesthesia, pulmonary edema, wound infection, peritonitis hematoma, cerebral thrombosis, fat emboli, gas gangrene, hemorrhage mesenteric thrombosis uremia traumatic arthritis of hip sciatic nerve palsy extruded nails broken drill points improperly placed nails and subsequent loss of position, protrusion of nail into acetabulum screw heads twisted off, disengaged bolt, breaking of plate nonunion femoral shaft fracture and hemologous serum jaundice

Many of these complications and most of these surgical deaths were due to the extremely poor general condition of the patient at the time of injury A more careful selection of the patients prior to surgery would lessen this mortality rate and decrease the number of complications.

But what is to be done with those who cannot have this major surgical procedure? If operation is performed on those more severely debilitated individuals, most of them will die and in those who survive the sur

* Waco, Texas

gical procedure, many of the complications just listed will occur and vitiate the end-result It was for this group of patients, whose general condition is so poor as to preclude surgery, that we began using the following method of treatment

## INSTRUMENTS AND MATERIAL NEEDED

Syringe 20 cc —1 long and 1 short needle
Procaine 2 per cent 50 cc
2 Steinmann pins
Pin cutter
Hammer
Drill
Felteen
Sheet wadding
Plaster
Modified well-leg traction splint

The Roger Anderson well leg traction splint, as purchased today from surgical supply companies, makes and maintains traction on the broken leg over the bottom of the foot of the good leg. Old people cannot tolerate well this constant pressure on the sole of the foot Too often, pressure sores develop on the foot, the heel or the malleoli particularly when the cast is applied inexpertly

We have modified and improved this splint by having drill holes placed in the stirrup part of the splint on the good leg side so *that the counter pressure is taken on a pin* through the tibia rather than on the bottom of the foot (Fig. 1)

## PROCEDURE

Reduction of the fracture and fixation with the modified well leg traction splint may be done on the patient s bed or on a stretcher or of course, on an operating-room table

The fracture site is anesthetized with 2 per cent procaine

Both legs are infiltrated with procaine at a point about 2 or 3 inches above the malleoli on both medial and lateral sides

Drill or drive a $\frac{3}{16}$ inch Steinmann pin through each tibia at a point about the ankle

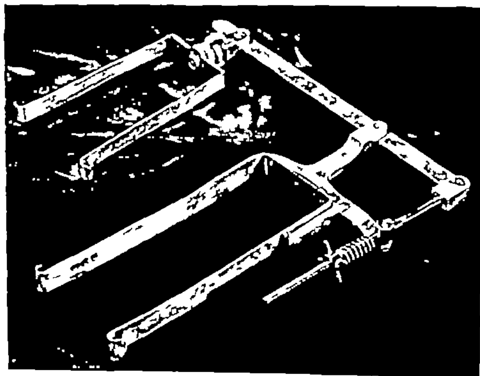


FIG 1 Modification of the Roger Anderson well leg traction splint by the drilling of holes in stirrup of the well-leg side.

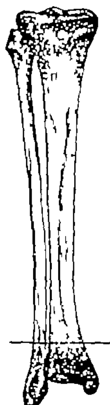
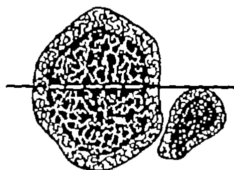


Fig 2 (*Left*) Area where pin should traverse tibia at place at which cortical bone is merging into cancellous bone

Fig 3 (*Right*) Cross section of tibia and fibula at area in which pin should be placed Note that if the pin lies close to the anterior edge of the fibula it will penetrate the middle of the tibia



judged to be the area in which cortical bone is changing into cancellous bone (Fig. 2) Do not place the pin too low in the cancellous bone because it may migrate up or down with pressure and become loose Do not place it too high in the cortical bone because this brittle bone may crack and the pin became loose If the pin is placed in the area in which cortical bone is merging gradually into cancellous bone it will not crack the bone and it will not become loose Insert the pin first on the *lateral aspect* of the tibia, immediately anterior to the fibula, which places it in the middle of the tibial shaft (Fig. 3) and furthermore here the pin can be guided more easily straight through at a true right angle to the bone and parallel to the table top

Place a sterile flat gauze sponge on each side of each pin and wrap on sterile sheet wadding.

Apply a cast from the bases of the toes to the knee on the broken leg side and to the mid thigh on the well leg side

Attach the well-leg traction splint to the cast in the usual way except that on the well leg side the metal strips are placed over the Steinmann pin in exactly the same way as on the broken leg side

Tighten the traction nut with the leg in external rotation until shortening is overcome Then rotate the leg internally to a neutral position and lock that holding nut. Place a strip of adhesive tape over the holding nuts to prevent curious friends from twisting them.

A roentgenogram now will show a practically perfect reduction but any overpull or underpull or improper rotation can be corrected easily by adjusting the 2 nuts on the traction device

## POSTOPERATIVE CARE

*The patient may and should sit up in a wheel chair for 2 or 3 hours or longer each day beginning immediately* This is most important He may and should be turned on the unbroken leg side occasionally while in bed and he may lie on his stomach. The position of the bone will not change no matter how the patient is moved if the 2 adjustable nuts are locked securely in place

Usually the patient leaves the hospital in 4 to 5 days Just before he leaves, loosen the traction nut about 2 turns to allow impaction of the fracture and to permit slight motion in the knee

The patient returns to the doctor's office for a roentgenogram in 1 month, and if any overpull is noted due to absorption about the fracture line this is corrected and the patient returns home In another month he returns for another roentgenogram and for removal of the casts and the pins. Sterile



FIG. 4 Showing the usual type of inter trochanteric fracture before reduction



FIG 5 Showing good union in an excel lent position at end of 3 months

dressings are applied to the pin holes which must not be changed for 3 weeks At this time the pin holes will be dry

During the next 30 days, after removal of the well leg splint, the patient remains in a non weight bearing status but he exercises his legs to regain motion and strength in them Then at the end of this month or 3 months from the date the fracture was set he may be allowed up with crutches which he may discard as soon as he desires The bone by the end of 3 months usually is per fectly strong, and the patient may carry weight on it (Figs 4 and 5)

## RESULTS

Seventy-six (36%) of the 212 intertrochanteric fracture patients whom I have seen have been cared for by this method of treat ment

Good follow up records have been se cured on 58 of these and on 104 of them treated by surgical implantation of an in ternal fixation device The longest follow-up record was 12 years the shortest 4 months.

Only 2 deaths (1 9%) in the major sur gical group (open reduction with internal fixation) occurred within a 10-day period of time thus reducing our surgical mortality rate for this group far below the general average This reduction of the surgical mortality rate is due largely to the careful screening of patients prior to operation.

In the group treated with a modified Roger Anderson well leg traction device, there were no deaths as a result of this minor surgical procedure and in the 3-month period of time following reduction of the frac ture only 1 death occurred, this being in an obese 78 year-old woman who had diabetes hypertension and heart disease She died of cardiac failure 6 weeks after the splint was applied

The average hospital stay in this group was 9 days

Good strong union in a most excellent position occurred in all with this 1 exception.

## COMPLICATIONS

The only complication of much importance was considerable residual stiffness in the knees and this occurred in only 10 (13%) of them However 7 of these had chronic rheumatoid arthritis at the time of injury

Bed sores occurred during the first 2 weeks in 18 (23%) of them, but all except 1 healed during the next 3 months

Thrombophlebitis occurred once this being in the broken leg This patient had, at

the time of the fracture an old-infected, indolent varicose ulcer on the medial malleolus area

*Hypostatic pneumonia bed sores thrombophlebitis* and psychic changes are the most common complications in old people who are kept in bed with a hanging-weight type of traction on the leg in the old-time conservative treatment of those fractures *These complications are avoided by having the patient sit up every day for several hours in a wheel chair* and it is due mainly to this I think that such complications are avoided in this modified well leg traction method of treating them

## SUMMARY

A conservative method of treating intertrochanteric fractures using a *modified well leg traction splint* in the severely debilitated patient is presented.

By the use of this minor surgical procedure the *surgical mortality* rate has been reduced to *zero* the over all mortality rate (surgery plus 3 months) has been reduced to 2 3 per cent, and the hospital stay has been reduced to an average of 9 days. And by a more careful screening of patients our surgical mortality in the open reduction with internal fixation group has been reduced to 1 9 per cent

The end results in these severely debilitated cases treated by this modified well leg traction device have been excellent and the complications few

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## Tractamento de Fracturas Intertrochanteric in Severmente Debilitate Patientes

*Summario in Interlingua*

Le objectivo del presente reporto es delinear un satisfacentissime methodo de tractar fracturas intertrochanteric in patientes de

etate avantiate qui es nimis severmente debilitate pro un major intervention chi rurgic como per exemplo un reduction aperte con insertion de interne medios de fixation

In iste methodo nos usa un modification del apparato de Roger Anderson a extension continue via le non-afficite gamba

Le autor presenta un revista del morbi ditate e mortalitate in altere methodos de tractamento Ille signala que in le methodo chirurgic hic describite il habeva nulle mortes in consequentia del intervention chi rurgic mesme. Le serie de patientes al base del presente reporto consisteva de 76 casos Inter istos un sol morte occurreva intra le prime tres menses post le reduction del fractura

Un bon union con excellente position resultava in omne patientes excepte in le un supra mentionate caso

Le autor signala le complicationes associ ate con su methodo Le principal es rigidi tate residue in le genu sed isto dispare in le curso de tres o quatro menses post le dis montage del apparato

Le autor describe su modification del apparato de Roger Anderson in detalio Le principal alteration es que le apparato es attachate de maniera que un spina pote esser placiate a transverso le tibia al latere verso le non afficite gamba e non solmente al latere que se trova sub extension

# 15

# Treatment of Humeral Cubitus Valgus

HENRY MILCH M.D *

Cubitus valgus increase in the size of the outward opening angle formed between the mechanical axes of the arm and the forearm may arise as the sequel of a number of different conditions that may be either accidental or congenital in origin. The site of the deformity, that is, the apex of the angulation, may be situated in the forearm bones or in the humerus The former gives rise to a forearm type the latter to a humeral type of cubitus valgus Since optimum correction of any angulational deformity is obtained at the apex of the angulation, it is essential to differentiate carefully between the 2 types in order that appropriate correction may be undertaken.

When the deformity arises primarily in the bones, the proper indication can be established with relative ease, even though the technic of carrying out the correction may involve great difficulty In principle such correction can be obtained either by wedge resection or by angulational osteotomy if the deformity is uniaxial or by a splinting subperiosteal osteotomy if the deformity is polyaxial. The real difficulty presents itself when the apex of the deformity is articular and osteotomy is impossible In such cases because only 1 bone is involved, it has been found to be desirable to consider the deformity as being of the humeral rather than of the forearm type As a consequence of this it is evident that 2 different types of humeral cubitus valgus must be given consideration

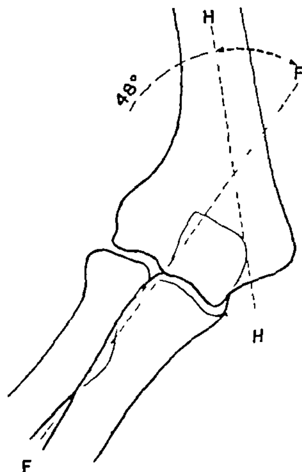



FIG. 1 Illustrating a humeral cubitus valgus of 48 such as might arise from a premature closure of the outer half of the epiphyseal line a malunited fracture, etc There is no dislocation of the ulna, the deformity is of a simple angulational nature, and it can be corrected by angulational osteotomy (H H) Humeral axis. (F F) Forearm axis.

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Type 1 is characterized by a relatively simple malalignment — either uniaxial or polyaxial Such cases may arise as a result of premature closure of the outer half of the lower humeral epiphysis after simple fracture of the external humeral condyle or after mal aligned supracondylar fractures (Fig 1) In each of these instances the axial deformity is either angulational or torsional in nature and correction can be effected by simple wedge resection or linear osteotomy with appropriate axial realignment (Fig. 2)

This type of humeral cubitus valgus dif fers from the Type 2 which is charac terized by the compounding of a simple angulational or torsional with a transposi tional malalignment. This type arises pri marily as a result of dislocation of the fore arm bones such as may be seen in Type 2 abduction fracture of the external condyle associated with lateral dislocation of the ulna * For this type of cubitus valgus sim ple angulational osteotomy is specifically *not* applicable Even when angular deformity was overcorrected so as to convert the val gus into a mild degree of cubitus varus the unesthetic appearance of the extremity per-

* Reported in paper delivered at the A.M.A. meeting (Orthopaedic Section) held at Atlantic City June 9 1955

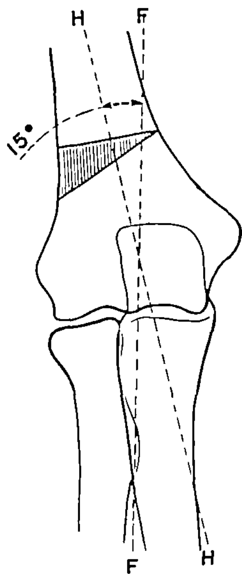



Fig 2. The same as Figure 1 after the performance of a supra condylar wedge osteotomy

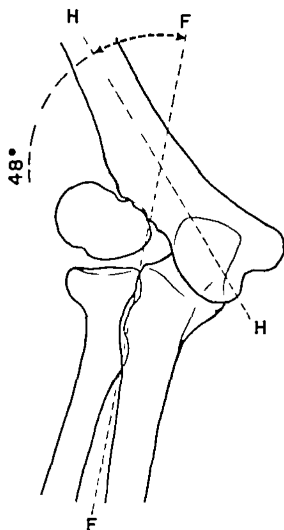



Fig 3 Illustrating a cubitus valgus of the same degree as that in Figure 1 but with an associated lateral dislocation of the ulna, such as seen in Type 2 fracture of the external humeral condyle

sisted. This arose from the fact that the ulnar dislocation was of a transpositional nature took place within the elbow joint and was therefore not amenable to a simple *angulational* type of osteotomy (Figs 3 and 4)

It was evident that before undertaking any correction of an angulational nature it was essential to correct the transpositional deformity due to lateral displacement of the elbow joint. Since the capitulum humeri acts as an efficient buttress for the radial head, it was clear that the level of the osteotomy would have to be above the proximal end of the fractured fragment. The exact site of osteotomy was determined by a study of a tracing of the roentgenogram (Fig. 5) It can be seen that upward projection of the forearm axis (FF) on to the lower end of the humerus intersected the inner cortex of the humerus at a point above the upper edge of the fractured fragment. Transverse section of the humerus at this level converted the extremity into 2 portions—an upper consisting of the proximal end of the osteoto-

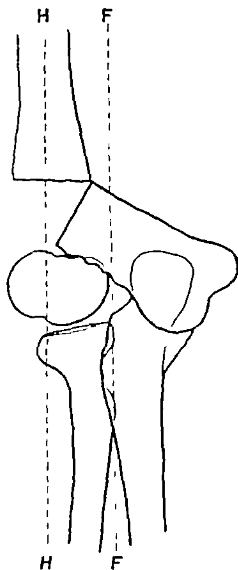



Fig. 4 As in Figure 2, a simple angulational osteotomy has been performed at approximately the same level The axial alignment has been overcorrected so that the carrying angle has disappeared entirely Despite this, the prominence of the medial condyle presents the appearance of a clinical cubitus valgus.

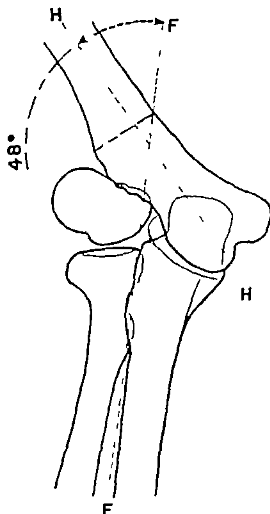



Fig 5 Schematic drawing that is identical with Figure 3 except that the site of the transverse osteotomy *perpendicular to the humeral shaft and proximal* to the upper end of the condylar fragment is indicated

mized humeral shaft and a lower consisting of the elbow joint with the distal end of the osteotomized humeral shaft. Outward transposition of the distal portion so that the axis FF intersected the humeral axis HH at about the mid point of the osteotomized humeral shaft served to correct the effect of the lateral displacement of the ulna (Fig 6) By this maneuver the deformity was reduced to a simple angulation that was corrected by appropriate adduction of the distal fragment so as to reduce the angle of valgus to the normal (Fig 7)

In actual practice, the procedure was carried out in the following manner

The patient was placed in the prone position with the forearm supported on an arm board A posterior muscle splitting incision *exposing the lower end of the humerus, but* without opening the elbow joint was made The fibers of the split triceps muscle were retracted and the ulnar nerve was identified (When indicated for the treatment of late ulnar palsy the flexor group was detached the ulnar nerve was transplanted forward and the flexor muscles were reattached.) The upper limit of the condylar fragment was

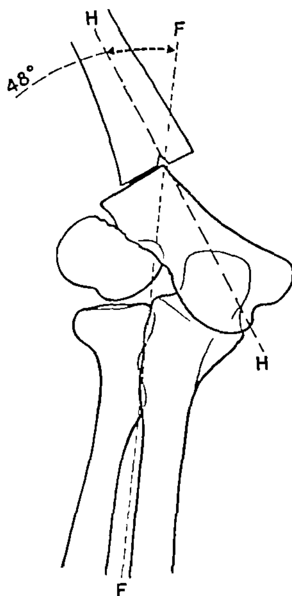



FIG. 6 Following the transverse osteotomy the distal fragment has been displaced outward into the notched undersurface of the proximal fragment so that the axis of the forearm intersects the axis of the arm at its mid-point. This transposition has not modified the axial angulation.

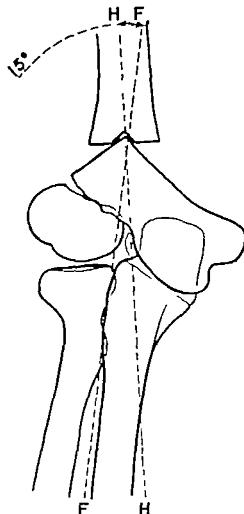



FIG 7 With the fulcrum at the site of the humeral notch the distal fragment has been angulated medially so as to reduce the valgus to the degree of the normal carrying angle.

noted as a landmark and at the level of the intersection of the forearm axis with the inner cortex of the humerus a simple transverse osteotomy was performed. The inferior surface of the proximal osteotomized fragment of the humerus was notched to receive the apex of the upper surface of the distal fragment of the humerus which was moved laterally The distal fragment then was adducted until the excessive angle of abduction had been reduced to the normal carrying angle. This was controlled by roentgenogram with the extremity in extension and the fragments then were fixed by the insertion of Kirschner wires The elbow was carefully flexed and immobilized in plaster of Paris molds, which were left on until there was evidence of bony union Thereafter the wires were removed, and motion was encouraged.

The results of this procedure are illustrated in the following reproduction of a patient previously reported.*

## SUMMARY

The apex of angulation in cubitus valgus may be situated in either the arm or the forearm Optimum correction can be obtained only at the site of maximum deformity and, therefore it is essential to differentiate between the forearm and the humeral types of valgus Wedge resection or simple linear osteotomy performed on the appropriate bone results usually in adequate cor

* Reported in paper delivered at the Clinical Conference of the Alumni Association of Hospitals for Joint Diseases held in October 1954



FIG 8 Roentgenograms before and after combined transpositional and angulational osteotomy In effect, the humeral shaft has been transposed medially to compensate for the lateral dislocation of the ulna

rection if the axial malalignment is of an angulational or a torsional nature When the apex of deformity is situated in the joint line as the result of a dislocation transposition must be effected before angulation can be corrected

The 2 types of humeral cubitus valgus and the action of the simple angulational osteotomy as well as that of transpositional osteotomy are illustrated by schematic drawings

The technic of the combined transpositional and angulational osteotomy is described and the result illustrated

## Tractamento de Humeral Cubito Valge

*Summario in Interlingua*

Cubito valge — augmento del externe angulo de apertura inter le axes de bracio e antebracio—pote resultar de un angulation extrorse del axe del humero o del axe del antebracio Cubito valge humeral — augmento del angulo inter le axe del humero e le plano de su superficie articular inferior —se presenta sub duo distincte formas.

In le prime de iste formas le cubito valge es simplemente de natura angulational Illo pote disveloppar se in consequentia de un retardation del crescentia in le medietate exterior del epiphyse o post malunion de un simple fractura abductional del externe condylo humeral Illo es corrigibile per simple osteotomia con re alineamento del axes de bracio e antebracio

Le secunde forma de cubito valge humeral es quasi specificamente un sequela de mal union in fracturas abductional type 2 del condylo externe Su signo pathognomonic es displaciamento lateral del antebracio lo que explica le grado extreme de cubito valge que se incontra in casos de iste genere Un simple osteotomia pote corriger le angulation inter bracio e antebracio sed illo non pote meliorar le apparentia inesthetic del prominentia excessive in le condylo humeral medial Iste aspecto es corrigibile solmente per medio de un typo special de osteotomia que es capace a eliminar non solmente le deformitate angulational sed etiam le deformitate transpositional. Detalios technic del methodo es presentate e le resultatos que pote esser obtenite per medio de illo es illustrate in designos lineal e reproductiones roentgenographic

# 16

# Management of Suppurative Arthritis Complicating Artificial Hips

A greater power than we can contradict hath thwarted our intent. —SHAKESPEARE *Romeo and Juliet*

F GARRETT PIPKIN*

## THE PROBLEM

The survey on femoral head replacement prosthesis conducted by the American Academy of Orthopaedic Surgeons stated that complicating infections were reported by 109 of the 550 orthopaedic surgeons using endoprostheses [5] In a survey of this nature an analysis of the type and the severity of the infection was not practical [4] However the committee did include the comment that the result of one infection was fatal, and that another resulted in a hip disarticulation.

* Kansas City Mo

In the author s series of 55 replacement prostheses during the past 6 years there have been 4 cases complicated by suppurative arthritis an incidence of 7 2 per cent. These cases, plus a "cleanup case from a 'hospital elsewhere " and a suppurative cup arthroplasty comprise the material for this report (see table below)

This incidence of infection is noteworthy since during this same 6 years *119* femoral fractures were nailed without the occurrence of a primary surgical infection The chief factor contributing to this high incidence of suppuration was a history of previous infec

| CASE | AGE | DIAGNOSIS | TYPE OF PROSTHESIS | ORGANISM |
|---|---|---|---|---|
| 1 | 32 | Degenerative arthritis secondary to healed suppurative arthritis | Collison | *Staphylococcus aureus* penicillin resistant |
| 2 | 46 | Malum coxae senilis | Collison | *Staphylococcus aureus* penicillin resistant |
| 3 | 50 | Avascular necrosis | J E M Thomson | *Staphylococcus aureus* penicillin resistant |
| 4 | 75 | Nonunion | J E M Thomson | *Staphylococcus aureus* penicillin resistant |
| 5 | 76 | Fresh fracture | Judet acrylic | Hemolytic and nonhemolytic *Staphylococcus aureus* sensitive to many antibiotics |
| 6 | 22 | Ankylosing osteomyelitis | Cup | *Staphylococcus aureus* (preantibiotics) |

tion One case of childhood suppurative arthritis (Case 1) without drainage for 26 years flared up and broke down as did 3 others with a history of some type of previous drainage This still leaves 2 cases which must be classified as primary surgical infection

The causative micro-organism in each instance was *Staphylococcus aureus* In 80 per cent of the cases the micro-organism was penicillin resistant.

## PREVENTION OF INFECTION

A recent study[3] of antibiotic resistant bacteria reported 85 per cent of micrococci cultured from the noses and the throats of *hospital attendants* proved to be penicillin resistant (Fig. 1) Data obtained for micrococci resistant to chlortetracycline were comparable These authors point out that "patients who harbor antibiotic resistant organisms in anatomic lesions do not represent the whole problem or even a major part of it The source of the infections is from *healthy carriers* We know of no measures that will get rid of carrier strains Spread is decreased or prevented by the proper isolation techniques especially regarding hands and the respiratory tract, and by limiting the number of personnel attending each patient."

The development of resistant strains of micro-organisms makes the resumption of other methods of defense advisable During the thirties a considerable amount of work

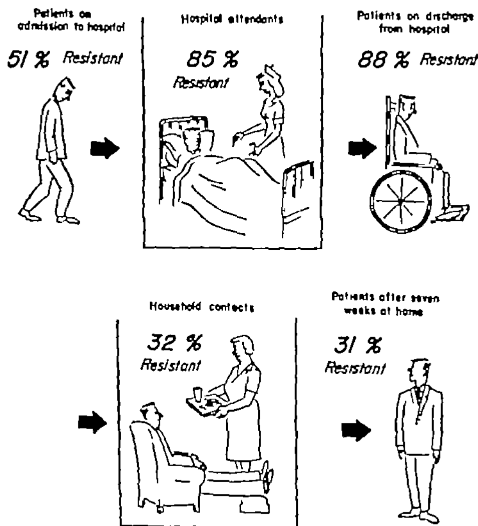



FIG 1 Percentage of penicillin-resistant micrococci cultured from the upper respiratory tracts of patients, hospital attendants and household contacts (Dowling, Lepper & Jackson J.A.M.A. 157 329)

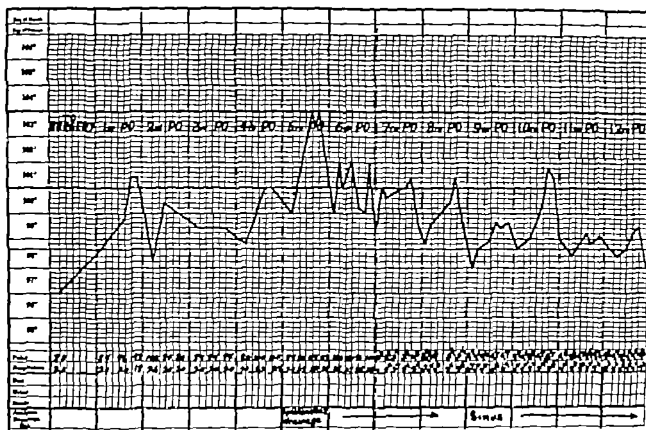


FIG. 2 Temperature chart illustrating immediate onset of infection. (Case 2)

was under way for the control of *Staphylococcus aureus* infections by the use of staphylococcus toxoid. Then came penicillin and *with it the feeling that soon the staphylococcus like diphtheria would be pushed into* oblivion. So interest in toxoid lagged.

In the Greater Kansas City Area during the late thirties staphylococcus antitoxin titration against the patient's serum was routine in cases of osteomyelitis and suppurative arthritis Patients with zero titer (i e., no circulating antitoxin) did poorly [10] Variation in immune serum also was supposed to explain why some little boys with *Staphylococcus aureus* in their noses got a hematogenous osteomyelitis and some did not.

The author has had a limited experience with the management of acute staphylococcic osteomyelitis and suppurative arthritis using toxoid as an adjunct to surgery after sepsis has developed. Zero titers were demonstrated in Cases 2 and 6 of this series. Although difficult to evaluate inasmuch as other measures were used also (surgical drainage transfusions chemotherapy and antibiotics) clinical improvement of the infection resulted *when a positive titer produced by increasing* serial toxoid dosage could be demonstrated in the patient's serum Toxoid therapy also was used empirically in Case 1

Staphylococcus toxoid has been improved since 1938 Previously the staphylococcus toxoid was prepared by treatment with Formalin which converts the toxin to toxoid. The new form of toxoid, staphylococcus toxoid (digest-modified) is prepared by the controlled peptic digestion of the staphylococcus toxin Peptic digestion not only changes the toxin to toxoid but also alters the allergenic quantities making larger dosage feasible The usual dosage starts with 0 1 or 0 2 cc twice weekly until a 1 cc. maintenance dose is reached. The objection to the use of a larger initial dosage is the occurrence of central necrosis In a situation in which time is of the essence this objec

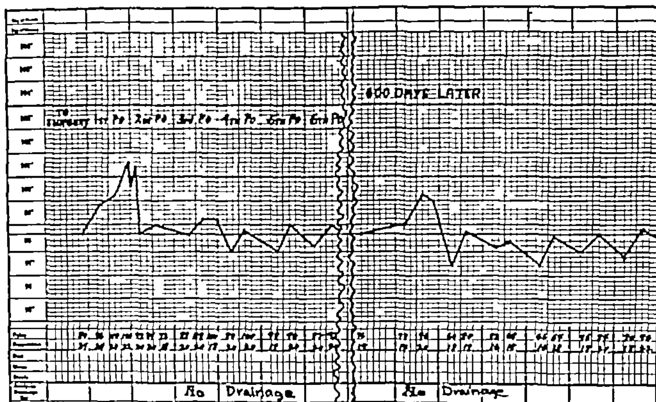



FIG 3 Temperature chart illustrating delayed, or smoldering, infection Surgical incision healed *per primum* Sinus developed 628 days after operation (Case 1)

tion can be circumvented by using multiple sites of injection namely, 5 injections of 0.2 cc of undiluted toxoid may be given the same day but at 5 different sites [7]

Before leaving this section on the prevention of infection it might be well to add that the occurrence of a surgical infection is the responsibility of the surgeon and not to be attributed to such generalizations as antibiotic resistant organisms. A serious concerted effort should be made by the surgical and the bacteriologic staffs to locate the leak. The break in technic may be obscure such as the sorting of linens from dirty cases in front of an air-conditioning intake or as simple as putting up surgical bundles and then neglecting to autoclave them. Constant unrequiting vigilance is the price of a good surgical team, and even then human errors will occur

## CLINICAL COURSE

The presenting symptoms of acute suppuration involving the new hip joint may be immediate (Fig. 2) delayed until antibiotic umbrella is lifted and/or active mobilization started (Case 3 — nineteenth postoperative day) or late (Case 2—17 months postoperatively) (Fig. 3) The closer the onset of infection to the operative procedure the more virulent has been its course In the face of a septic course the author has tried to temporize with additional antibiotics and immobilization, only to obtain the same inevitable result i.e wound breakdown and sinus formation Drainage may be modified by the use of additional suitable antibiotics but in each instance has persisted until the prosthesis has been removed

In the light of recent reports on the use of isoelectric metals in infected wounds it might be considered possible to dry up a smoldering prosthesis with suitable antibiotic therapy An infected vitallium replacement for a skull defect healed without its removal.[1] Internal metal fixation for arthrodesis of tuberculous joints has been reported.[2] Medullary fixation of infected femoral fractures has been continued until union of the fracture resulted.[6] The essential difference among

these examples and an infected endoprosthesis would appear to be the element of motion.

Whatever rationalizations a surgeon may employ in his attempts to dry up an infected hip *soon or late he must face the brutal fact that it will not work and that the prosthesis must be removed* Failure to remove the prosthesis soon enough may jeopardize the salvage value of the case (Case 5)

## TECHNIC OF REMOVAL OF AN INFECTED ENDOPROSTHESIS

The removal of an infected endoprosthesis is a major procedure so that both the patient and the surgeon should be as well prepared as possible Excision of the head and the neck of the femur in Girdlestone's series carried a 3 per cent mortality [9]

A recent culture of the organism present including an antibiotic-sensitivity survey is mandatory For example the initial culture made when the hip first broke down may have demonstrated a hemolytic *Staphylococcus aureus* sensitive to chlortetracycline (Aureomycin) After several weeks of temporizing employing chlortetracycline a second culture may reveal a hemolytic staphylococcus, chlortetracycline fast but sensitive to chloramphenicol (Chloromycetin) or erythromycin (Ilotycin) Thus the proper antibiotic for the present situation should be identified, and the proper dosage started 48







FIG 4 Method of wound closure showing location of secondary drainage through former Smith-Petersen nail tract and postoperative immobilization.

hours prior to the proposed surgery If the micro-organism is sensitive to several antibiotics it is wise to elect one that may be given intramuscularly or even intravenously in case postoperative nausea and vomiting prevent its oral administration

It is almost elementary to state that adequate blood replacement should be available and should be used to combat the hemolytic anemia before and after surgery and also to combat possible operative shock during surgery

The surgeon should identify the type of prosthesis, so as to have available any special instruments that might be required for its removal This is particularly true if the prosthesis is one that the surgeon did not insert himself Stem prostheses present no special problems. Most of the Collison plates were attached to the femoral shaft with cruciate screws so it would be embarrassing to arrive at the operative field with only a conventional screwdriver Continued suppuration may produce a bony escarpment over a supporting plate which is not always identifiable from preoperative roentgenograms A chisel or an osteotome may be required. Some early assemblies required the use of wrenches

The incision elected for the removal is generally that of the previous surgery although as a rule the incision need not be as extensive It is best to excise the old scar and draining sinus *en bloc* Surgical silk or cotton should be removed as the field is developed

The actual dislocation of the infected prosthesis requires little force and then may be extracted manually from its femoral insertion Sterilized white cotton gloves with a single snap at the wrist, such as those worn by minstrels are most useful in this step for two reasons (1) they permit a firmer grasp upon the slippery head, (2) they offer additional protection to the surgeon s hands while he is working at the bottom of a minimal incision where sharp bone remnants may exist which would tear rubber gloves easily and might even lacerate his hands



Fig 5 The former Smith Petersen nail or axle tract is utilized for drainage The great trochanter is not sacrificed in a cleanup

The author has not found it necessary to remove the trochanter or to ream or curette the femoral stem tract or the acetabulum The prosthesis has stimulated its usual connective tissue membrane and modified it into a synovial-like structure which at this point has been thickened by inflammation This membrane effectively pockets the suppuration about the prosthesis and prevents the invasion of the surrounding trochanteric bone Small sequestra resulting from bony debris of the previous reconstruction, should be identified and removed. Hemostasis is secured, and the wound is lavaged.

It has been the author s practice to close the wound tightly in layers with interrupted chromic catgut sutures Drainage is obtained by a small counter incision at 5 o clock on the trochanteric dimple sufficient to permit the insertion of a ⅜ inch diameter metal rod through the tunnel in the trochanter left either by the former Smith Petersen nail tract or by the axle of the prosthesis, and into the center of the acetabular hollow (Figs 4 and 5)

Such a type of closure was advised and used by surgeons at the turn of the century

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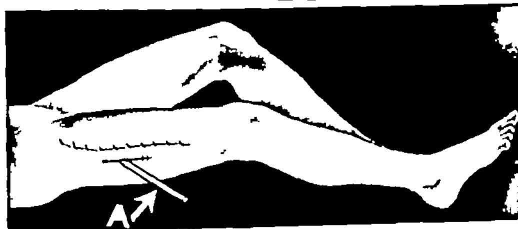
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hours prior to the proposed surgery If the micro-organism is sensitive to several anti biotics it is wise to elect one that may be given intramuscularly, or even intravenously, in case postoperative nausea and vomiting prevent its oral administration

It is almost elementary to state that ade quate blood replacement should be available and should be used to combat the hemolytic anemia before and after surgery and also to combat possible operative shock during sur gery

The surgeon should identify the type of prosthesis so as to have available any spe cial instruments that might be required for its removal This is particularly true if the prosthesis is one that the surgeon did not insert himself Stem prostheses present no special problems. Most of the Collison plates were attached to the femoral shaft with cruciate screws so it would be embarrassing to arrive at the operative field with only a conventional screwdriver Continued sup-puration may produce a bony escarpment over a supporting plate which is not always identifiable from preoperative roentgeno-grams A chisel or an osteotome may be re quired. Some early assemblies required the use of wrenches

The incision elected for the removal is generally that of the previous surgery al though as a rule the incision need not be as extensive It is best to excise the old scar and draining sinus *en bloc* Surgical silk or cot ton should be removed as the field is devel oped.

The actual dislocation of the infected pros thesis requires little force and then may be extracted manually from its femoral insertion Sterilized white cotton gloves with a single snap at the wrist, such as those worn by minstrels are most useful in this step for two reasons (1) they permit a firmer grasp upon the slippery head (2) they offer ad ditional protection to the surgeon's hands while he is working at the bottom of a mini mal incision where sharp bone remnants may exist which would tear rubber gloves easily and might even lacerate his hands



Fig 5 The former Smith-Petersen nail or axle tract is utilized for drainage. The great trochanter is not sacrificed in a cleanup

The author has not found it necessary to remove the trochanter or to ream or curette the femoral stem tract or the acetabulum The prosthesis has stimulated its usual con nective tissue membrane and modified it into a synovial like structure which at this point has been thickened by inflammation This membrane effectively pockets the suppura-tion about the prosthesis and prevents the invasion of the surrounding trochanteric bone Small sequestra, resulting from bony debris of the previous reconstruction, should be identified and removed Hemostasis is se cured, and the wound is lavaged

It has been the author's practice to close the wound tightly in layers with interrupted chromic catgut sutures Drainage is obtained by a small counter incision at 5 o clock on the trochanteric dimple sufficient to permit the insertion of a ⅜-inch diameter metal rod through the tunnel in the trochanter left either by the former Smith-Petersen nail tract or by the axle of the prosthesis and into the center of the acetabular hollow (Figs 4 and 5)

Such a type of closure was advised and used by surgeons at the turn of the century

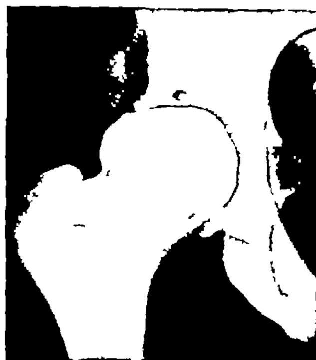


FIG. 6 (Case 1) Degenerative arthritis following healed childhood suppurative arthritis.



FIG. 6 (*Cont*) Final result pseudarthrosis 6 years later

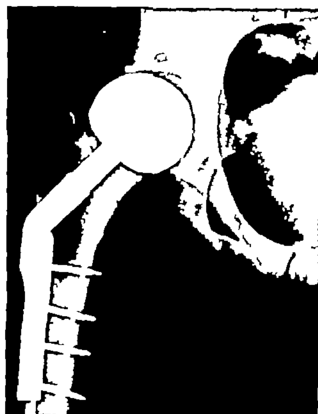


FIG 6 (*Cont*) Collison prosthesis.

when excision of the hip was practiced more commonly [11] Here it has been modified slightly to use the already established tract through the trochanter which as pointed out is lined with a connective tissue membrane

No attempt is made to place the trochanter in the acetabulum

A spica and one half cast is applied and worn for as little as 10 days and for as long as 3 months postoperatively (Fig 4) Fever pain muscle spasm and the nature of drainage determine the length of time in plaster

The tubular drain served as a means of irrigation with bacitracin in one case in which the micro-organisms were so sensitive Dakin s solution was used in one case In the remaining cases the tube was incorporated in the cast wall for 7 to 10 days Then the cast was windowed and the tube was withdrawn gradually over a period of another week so as to ensure the establishment of a sinus These sinuses have closed as soon as 3 weeks postoperatively and as late as 18 months In the latter case a secondary simple incision and drainage was necessary 4 months postoperatively at which time the sinus had closed prematurely

The immediate postoperative period is generally critical A competent internist familiar with the medical management of sur



Fig 7 (Case 2) Malum coxae senilis.

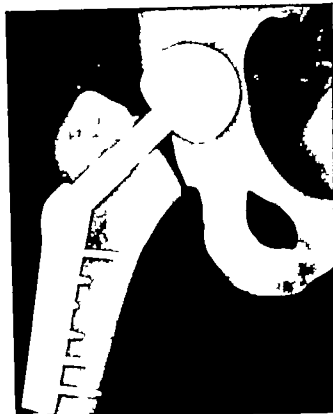


Fig 7 (*Cont*) Collison prosthesis.



Fig. 7 (*Cont*) Final result fibrous ankylosis 6 years later

gical cases is highly desirable An embolic or bronchopneumonia occurred in one case There was EKG evidence of a toxic myocarditis in one case Special nurses are advisable if they are available and if the already heavily taxed resources of the family can afford them.

In all instances the patient has survived Mobilization from bed to wheel chair to walker to crutches and in 2 instances to unsupported weight-bearing has required periods of time varying from a few months to 2 years

Obturator neurectomy was performed in 3 cases as a supplementary procedure for obturator neuralgia. It was considered of value in 2 of these cases because it not only reduced pain but also obtained better muscle balance about the hip

## RESULTS

### Functional

A purposeful pseudarthrosis has been the end-result in these cases. Follow ups of 2 to 15 years are available Serial roentgenograms of Cases 1 2 and 3 demonstrate their present status (Figs 6-8)

Case 2 has the best result. This patient has a painless stable pseudarthrosis with 25 flexion extension (Fig 6) Shortening of 1¼ inches existed prior to operation for malum coxae senilis and is not objectionable from the viewpoint of the patient. He has built his own house during his spare time within the past 2 years

Two women have 'Drumstick" hips,

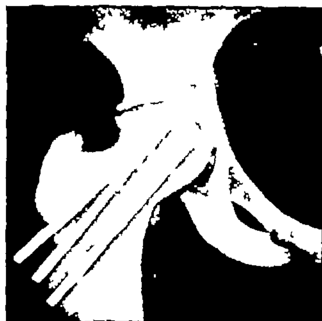


Fig 8 (Case 3) Avascular necrosis 4 years after hip pinning.



Fig. 8 (*Cont*) Final result pseudarthrosis 4 years later



Fig. 8 (Cont) J E. M Thomson acrylic prosthesis.

stabilized only by the gluteal hammock (Figs 6 and 8) Shortening in each instance approximates 2 inches One patient is ambulatory without support. The other has from 6 to 7 hours daily weight-bearing stamina using one Canadian crutch before backache develops (Fig 9) Rotation in each case is limited. The theoretical question of external rotation deformity has been raised by one orthopaedic surgeon reviewing these cases The fit of the flat trochanteric surface against the flat of the ilium anatomically prevents much rotation, so that external rotation deformity has not developed No braces or calipers have been used.

Case 4 an obese elderly female who has been confined before and after operation to a nursing home has not progressed beyond a wheelchair and a very labored walker existence

Case 5 a 75-year-old female, in which the prosthesis was inserted at a "hospital elsewhere" and was treated by the author as a cleanup procedure after 1 year's drainage, is a bedridden codeine addict. Her hip has healed but an almost stiff painful knee (cast arthritis) which was inherited with the suppurative hip prevents mobilization She refuses to consider any procedures to mobilize her knee.

### Economic and Social

Case 1 reported that his medical surgical nursing and hospital bills covering a 2 year period of disability approximated $7 000





Fig 9 (Case 3) Purposeful pseudarthrosis of right hip showing functional result 4 years after final operation.



Fortunately his business was such that he could manage it from his home during his convalescence He made the interesting comment that his drug bill for antibiotics amounted to more than his combined surgical and medical fees At present he is continuing his work as a salesman traveling his daily territory and driving his own automobile

One woman was deserted by her husband. The majority of her surgical and hospital expenses were written off At the present time she is self-supporting at sedentary work.

The husband of another patient arranged for and obtained a divorce after she had been ambulatory for 1½ years At present she is active in church work, in addition to which

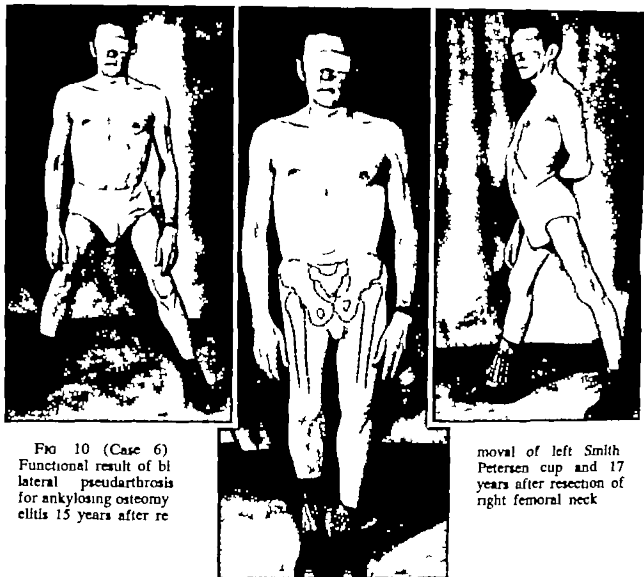


FIG 10 (Case 6) Functional result of bilateral pseudarthrosis for ankylosing osteomyelitis 15 years after removal of left Smith Petersen cup and 17 years after resection of right femoral neck

she has a vital interest in life centering in her grandchildren

One woman is on domiciliary care

One woman is still in the hospital, which her independent means permit. She is a codeine addict

Case 6 a bilateral salvage operation continues healed 15 years after removal of his cup (Fig 10) He is ambulatory without support of any type He is married, has 2 children and is economically independent as a commercial photographer

## CASE REPORTS

Case 1 Mrs. F P., aged 32 admitted March 8 1949 with complaint of pain and limited motion in right hip and low back. "Hip trouble" at age of 6 "Peritonitis" and drainage No subsequent drainage Roentgenograms (Fig 5) Diagnosed as degenerative arthritis following a healed suppurative arthritis Functional shortening of 2 inches TPR flat. ERS (Cutler) 5 1 mm in 1 hour WBC 10 400 with 75% polys.

Collison prosthesis by D McKeever and Pipkin on March 12, 1949 Temperature spiked to 101 F first postoperative day and thereafter leveled (Fig. 3) Penicillin and streptomycin discontinued seventh postoperative day Required only 2 "hypos" during entire postoperative course. Discharged twenty-ninth postoperative day on partial weight bearing, using crutches.

Second admission August 10 1949 Had been free from pain and walking with the aid of only one crutch when pain and muscle spasm developed in hip Temperature varied from 98.2 F to 99 0 F RBC 4 810 000 WBC 10,500 Improved with traction Discharged in 7 days.

Third admission, July 23 1950 Recurrent

pain and muscle spasm with pain radiating down to knee TPT flat (Fig 3) Blood counts normal Pain improved by external obturator neurectomy

Fourth admission November 20 1950 Incision of obturator neurectomy broke down and sinus tract extending down to prosthesis identified *Staphylococcus aureus* sensitive to Terramycin cultured Discharged November 27 1950 on Terramycin

Fifth admission, December 8 1950 Drainage had continued with loss of 14 lbs. weight and some fever RBC 4,310 000 WBC 11,500 Removal of prosthesis, counter drainage hip spica and toxoid 2 units of blood Main incision healed per primum Drain removed on the seventh postoperative day Cast removed on the fourteenth postoperative day Slight spotting at site of counter drainage for several weeks.

Present condition Has continued healed Ambulatory with 2 inches shortening Refuses to wear lift on shoe and has backache at end of day No cane or crutch. Full knee motion Husband deserted her She is gainfully employed

Case 2. R. P., aged 46 Admitted November 29 1949 with complaint of pain deformity and limited motion right hip Shortening 1¾ inches. History of hip trouble since age of 12 years. Has worn lift on shoe for several years. No longer afforded relief Roentgenograms show malum coxae senilis secondary to probable old slipped epiphysis. Collison prosthesis December 2, 1949 (Fig. 7) Temperature 104 F fifth postoperative day followed by pain in left shoulder blade, chills sweats and prostration (Fig 2) Transfusions, penicillin Terramycin and immobilization. Wound moist and pus on fifth postoperative day Cultured hemolytic *Staphylococcus aureus* coagulase and mannite positive, resistant to penicillin and sensitive to Aureomycin 0.2 mg per cc., and to streptomycin to 0.2 mg per cc Aureomycin, toxoid, transfusions, hip spica and special nurses improved general condition. Probable chest complication and some EKG changes during height of infection. Sinus persisted. Prosthesis removed March 4 1950 3 months after original operation Attempted primary closure with counter drainage broke down Several sinuses developed which were controlled intermittently with Aureomycin. Hip spica 3 months. Drainage continued until July 1 1951 when large abscess was incised, and healing occurred. Required an additional 1½ years to regain strength and stamina.

Present condition He sits, stands and walks well without even a cane Wears a special shoe with modified 2 inch lift which costs $60 Has no pain at any time Hip has 15 painless flexion-extension at 25° neutral flexion (Fig 7) This amount of motion permits him to sit with more comfort than a patient with an arthrodesed hip The knee flexes to 90 He is driving his own automobile as a salesman During the past 2 years he and his wife have built their own home during their spare time

Case 3 Mrs. D P., aged 50 Admitted January 2, 1951 for painful right hip increasing in severity past 4 months Sustained capital fracture 4 years previously treated by multiple threaded pins Postoperative drainage healed in 10 days, and the extremity had been useful until recent pain developed. Shortening of ½ inch. Slight deformity pain and muscle spasm Roentgenograms showed degenerative head with 3 pins in situ (Fig. 8) On February 4 1951 J E. M Thomson acrylic type arthroplasty Penicillin 400 000 units I M B.I.D Terramycin stopped after vomiting one dose Temperature to 101 F 3 days after operation and thereafter was normal. General condition so good that on the ninth postoperative day ram s horn nail was removed under local anesthesia. Hip spica removed, and the patient was in a wheel chair on the twelfth postoperative day Pain and fever to 101 2 F developed on the sixteenth postoperative day Cultured hemolytic *Staphylococcus aureus* mannite positive and coagulase negative Pseudomonas also cultured. Both organisms were inhibited only by Terramycin and Aureomycin Prosthesis removed on the thirtieth postoperative day Primary closure of the main incision with secondary counter drainage using a tube through the trochanter incorporated in a hip spica was done. Immediate postoperative course stormy Cast was windowed third day and Dakin s irrigations were instituted. Hip spica was changed to Buck s traction on the tenth postoperative day by which time temperature was approximately normal Terramycin and transfusions used. The main surgical incision healed per primum. The counter incision closed and remained healed after the nineteenth postoperative day Pain persisted and was improved by an obturator neurectomy March 4 1951 Mobilization begun 5 days later Patient was discharged, using a wheelchair and a walker March 26 1951 In the course of the following year she graduated to one Canadian crutch

Present condition (Fig. 9) Still depends on one Canadian crutch, although she can walk limited distances without it. Develops backache after 6 or 7 hours of weight-bearing. Passively

her hip has a wide range of motion with demonstrable telescoping Has no pain in her hip Her knee has full range motion. Vitally interested in her grandchildren and carries on active program of church work. The day these pictures were made she had baked an enormous number of cakes for a church social to be held in her home the next day

Case 4 Mrs. E T aged 75 years, an obese senile female with CNS syphilis On January 1 1950 she sustained a displaced subcapital fracture. On January 9 1950 open reduction S.P nail overdriven bar and bone graft. On January 27 1950 bar removed and nail depth adjusted. On January 30 1950 transferred to Kansas City General Hospital Discharged, using crutches 6 weeks later She sustained a fall 3 weeks later Roentgenograms showed nail cut out and nonunion. S P nail and bone graft removed July 3 1950 On July 29 1950 arthroplasty using acrylic prosthesis. Trochanter transplanted Drainage developed persisting for 6 weeks. On March 29 1951 unstable prosthesis. Pain and contracture Arthroplasty substituting another acrylic prosthesis. No drainage On August 21 1952 loose greater trochanter was reattached with screws adductor tenotomy A very stormy postoperative course with psychosis demanding restraints followed each surgical procedure The greater trochanter again pulled loose, decubitus ulcer developed and drainage appeared. Screws removed November 13 1952 Drainage persisted Flexion deformity Discharged January 25 1953 using crutches. Drainage persisted. On September 2 1953 culture of sinus tract revealed hemolytic and nonhemolytic staphylococcus sensitive only to Chloromycetin. Prosthesis removed Drainage persisted On December 10 1954 nursing home status.

Present condition Has developed renal calculi continues on nursing home status. She is vegetating and able to get about in a wheel chair Sinuses healed. Hip painful and telescopes on attempted weight-bearing

Case 5 Mrs. L. H aged 76 years, transferred April 15 1953 from "hospital elsewhere" with multiple draining sinuses about the left hip and painful fibrous ankylosis of the left knee, requiring codeine gr 1 Q I.D History of capital fracture January 1952, treated immediately by replacement prosthesis. Surgical incision healed per primum Although hip continued painful she had attained a partial weight bearing status with the aid of a walker by the thirtieth postoperative day Six weeks after operation the hip drained spontaneously Since then drainage has been controlled intermittently using hot packs and antibiotics The sinuses cultured *Staphylococcus aureus* nonhemolytic, positive coagulase and mannite sensitive to a wide range of antibiotics, including penicillin. On April 20 1953 prosthesis was removed with usual technic Primary closure not obtained. Incisional slough healed so that Hubbard tank could be started June 10 1953 Hip gradually became pain free Knee has continued painful and has only a few degrees of motion. Patient co-operated for a few months. Then she refused to get out of bed or to consider any further efforts at mobilization Continues on codeine Q.I.D Her financial status permits her to continue her existence as a patient in a private hospital room She is bitter and castigates daily all doctors who have attended her including the author

Case 6 J H aged 21 years February 6, 1938 admitted due to ankylosis of both hips, secondary to hematogenous osteomyelitis and suppurative arthritis Onset occurred at age 13 involving right ankle and subsequently almost every bone in his body both hips, ribs, mandible elbows, arms and shoulders. Has been hospitalized many times. Since hips had become involved 5 years previously he had been confined to bed continuously Right hip had bony ankylosis. External rotation deformity of 85 Left hip had partial fibrous ankylosis, with moderate deformity and a still draining sinus. Other scars of multiple incisions for drainage had healed. The right hip was treated by purposeful pseudarthrosis by resecting the femoral neck. This raised the patient's status to that of a wheelchair and the occasional use of crutches. On September 6 1938 the left hip flared, simulating a pelvic abscess but quieted with rest. Drainage persisted from left hip in diminishing amounts for the following year By May 27 1940 no drainage had occurred for 3 months Falsely emboldened by the advances of chemotherapy a cup arthroplasty was undertaken. A nidus of frank pus was excised during this procedure, which cultured *Staphylococcus aureus* Otherwise viable bone was contourable so that the cup was inserted. Postoperative coverage with staphylococcus antitoxin and sulfanilamide dried up the immediate ooze. The patient's staphylococcus titer was zero It was stimulated to a positive 1 1 level with toxoid by July 1 1940 Several secondary incisions and drainages of pockets were required. The patient was discharged on July 29 1940 in a hip spica with a draining sinus. He was instructed

regarding weekly toxoid therapy On September 6 1940 he was readmitted On removal of cast the Smith Petersen cup could be seen presenting in the sinus. It had dislocated and been partially extruded It was easily lifted from the sinus after an episotomy of the surrounding scar The sinus then healed rapidly Ankylosis did not recur The patient graduated to crutches to cane to full weight-bearing within 1 year

His present physical status 15 years after his last operative procedure is illustrated in Figure 10 He has had no further drainage His hips are not painful and are reasonably stable His physical stamina is sufficient for him to earn his living as a professional photographer He is married now and has 2 children.

## SUMMARY


1 Purposeful pseudoarthrosis of the hip joint has long been a recognized salvage procedure[8 9 11] Its use in the management of 6 cases of suppurative arthritis complicating artificial hips has been reported in detail A pseudoarthrosis in each instance was obtained by the removal of the appliance without the removal of additional bone from the acetabulum, or the trochanteric areas Healing of the suppurative arthritis has resulted. Four of the 6 cases reported have been restored to an independent useful life with physical limitations, as described

2 In selecting cases suitable for an artificial hip the elimination of those cases with a history of previous drainage of any type would have reduced the morbidity of this series from 6 to 2 cases. In retrospect, immediate purposeful, pseudoarthrosis created by excision of the head and the neck of the femur would have been better surgical judgment for these 4 cases

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*Summario in Interlingua*


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mover le inficite prosthese satis prompte mente on curre le risco de render le caso insalvabile.

Lo que nos require es un technica de remover un inficite endoprosthese utilisante le tracto del axe del previe canal de clavo pro le drainage e un firme clauditura. Nos non essayo placiar le trochanter a in le acetabulo

Le resultato que nos ha obtenite in omne nostre casos post que le arthritis suppurative esseva curate pote esser designate como un pseudoarthrose intentional. Omne nostre patientes ha supervivite Es presentate 6 casos Quatro de illos concerne patientes qui eseva restaurate a un vita independente e utile ben que subjicite a certe limitationes physic.

# 17

# Combined Use of External Skeletal Fixation and Internal Screw Fixation in Tibial Shaft Fractures

NATHAN E BEAR, M.D, F A C S, F I C S*

and

WM JOHNSON, M D F A C.S, F I C.S†

In a clinical study we treated 60 fractures of the tibial shaft with external skeletal fixation. In the first group of 30 cases the treatment was closed reduction and external skeletal fixation In the second group of 30 cases, the treatment was open reduction and fixation with internal screws plus external skeletal fixation. Because obtaining comparative data was our objective we excluded fractures in children, undisplaced fractures in adults as well as old cases of delayed union. Otherwise this was a consecutive series of simple or compound fresh fractures of the tibia with sufficient displacement or comminution to merit some type of skeletal fixation

## METHOD OF TREATMENT

All simple and compound fractures of the tibia included in this study were reduced, and fixation was applied as soon as possible after the patient's admission to the hospital unless some secondary condition provided an adequate contraindication to early surgical intervention. General anesthesia was used in all patients regardless of age Open reductions (second group) were all done on an operating table because mechanical traction was not needed.

After we had prepared the entire leg and foot with Septisol and sterile water we first drilled two $\frac{5}{32}$-inch transverse through and through pins in the proximal portion of the tibia and two similar through-and through pins in the distal fragment. These pins were drilled through the tibia with an awl-type drill handle to avoid the danger of thermal necrosis, which often results from the use of a speed drill We consider hand-drilling an important part of the technic in spite of the fact that it is slow and tiresome Often surgeons have blamed osteomyelitis on the use of pins when actually the bone necrosis was caused by poor surgical technic and judgment. Thermal necrosis can very well be the forerunner of a spreading osteomyelitis It is also important to drill the pins at a slight angle so that they will not be parallel. If either pair of pins is parallel, the tibia may slip laterally on the pins after fixation. To avoid soft tissue tension on the pin, which results in pin seepage one must not change the direction of the pin after piercing the skin.

After placement of the pins has been completed, an incision is made to expose the fracture of the tibia with a subperiosteal dissection in the usual manner The hematoma is removed, and the fracture is reduced manually and held in reduction with bone clamps Stainless steel screws, long enough to penetrate both cortices are then drilled across the fracture lines at the spot where

* Monroe Wisconsin

† Galesburg, Illinois

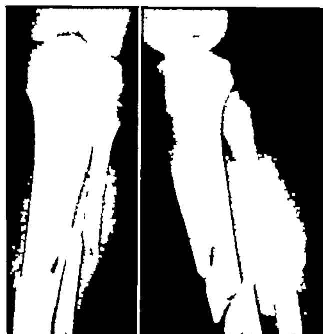
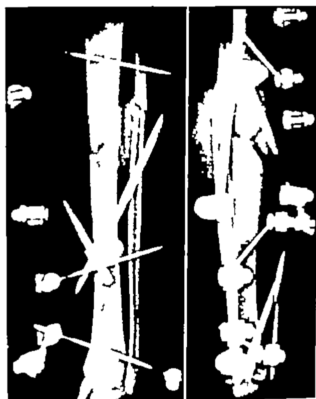


Fig 1 Case 1 Aged 17 Closed reduction external skeletal fixation applied for immobilization 101 days solid union in 98 days and disability 140 days





the greatest amount of fixation strength is obtained No attempt is made to keep the screws transverse to the bone they are placed more nearly transverse to the fracture line The smallest possible number of screws is used very often one is sufficient if there is only one oblique fracture line Screw holes in the proximal cortex usually are drilled larger than the screw to obtain impaction when screws are tightened The heads are countersunk in the bone

After the screws have been placed satisfactorily and the bone clamp is still holding the fracture in reduction Roger Anderson

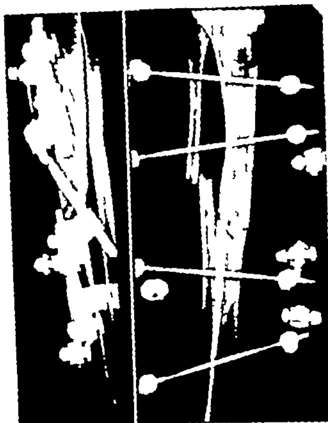


FIG. 2. Case 2. Aged 24 Closed reduction external skeletal fixation for 103 days solid union 103 days disability 207 days.





coupling units are fixed to the 4 Steinmann pins on both sides of the leg and secured with one or more long rods on each side Bilateral rods provide a firm fixation so that no undue force from leg movement, muscle spasm etc. can fracture the cortex around the screws and loosen the internal fixation. After all coupling units have been tightened, the bone clamp is removed and the wound is closed with wire sutures There is no need to lift the leg off the table until all fixation is applied firmly Small dressings are applied firmly around each pin, and a separate dressing over the wound.

When compound fractures are treated in this manner the débridement of the wound and the usual cleansing procedures are carried out prior to inserting the pins Definitive surgical procedures, reduction and fixation have been done on all patients with compound fractures as soon as poss admission to the hospital. These w be dressed separately for inspection ment later



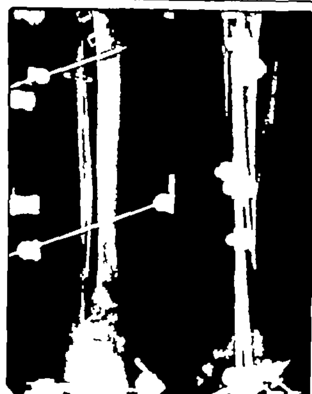


FIG 3 Case 3 Aged 50 Closed reduction external skeletal fixation for 443 days solid union, 735 days disability 302 days 25 per cent permanent partial disability

## RESULTS

### 60 Fractures of Tibial Shaft

| | External Skeletal Fixation (30) and Closed Reduction | External and Internal Fixation (30) with Open Reduction |
|---|---|---|
| Total days of external immobilization | 110 | 104 |
| Days before weight bearing allowed | 146 | 114 |
| Days of total disability | 170 | 127 |

## DISCUSSION

Figures used for a study of this kind depend on personal criteria for the allowance of weight-bearing and return to work. There can be a wide range of opinion as to when bony union has taken place from the appearance of callus to the closure of the fracture line Because of these obvious reasons, statistics of this type are worthless if compared with another author's data Each of the 2 authors had an equal number of cases in each of 2 groups and the same criteria for comparison were used. A few patients resumed light selective work, either with the aid of crutches or a walking cast after removal of pins before union had taken place





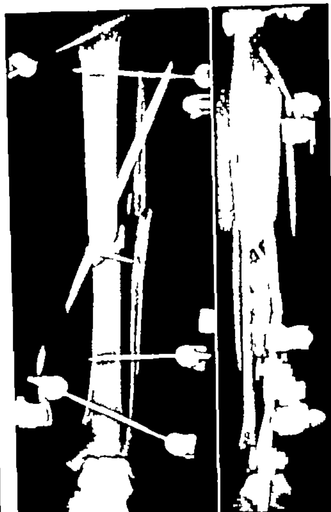


Fig 4 Case 4 Aged 25 Open reduction and 1 screw across fracture line external skeletal fixation for 103 days solid union, 178 days full weight bearing, 128 days disability 128 days

This period of part time work was not considered as a return to work. One patient treated with external and internal fixation who was included in the second group had a much longer healing time than any of the others because of a popliteal thrombosis which developed at the time of injury This patient caused a considerable increase in the average healing time of the second group

Shortened healing time in the second, or open reduction, group can be attributed to (1) accurate reduction (2) firm apposition with compression at the fracture line and (3) good immobilization. Eggers * excellent experimental work demonstrated the importance of "The Three C's" in treating all fractures—continuity contact, and compression. We believe that open reduction and some form of internal fixation (i.e screws, plates or intramedullary nails) is necessary to accomplish "The Three C's " Failure to achieve these important objectives may be largely responsible for a high percentage of delayed unions Four months is adequate time for weight bearing union, and cases taking a

* Eggers, G W N., Schindler T O., and Pomerat C M Influence of contact compression factor on osteogenesis in surgical fractures, J Bone & Joint Surg. 31 A:693 1949



FIGURE 4 (*Continued*)



FIG. 5 Case 5 Aged 33 Third fragment required 2 screws for immobilization external skeletal fixation, 134 days weight-bearing, 110 days solid union 134 days disability 150 days.

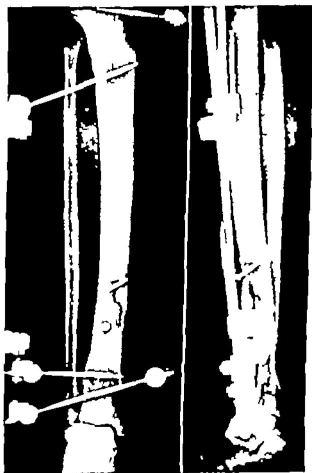


FIG 6 Case 6 Aged 38 Separate third fragment required 3 screws external skeletal fixation 67 days solid union 67 days weight-bearing, 86 days disability 86 days.

longer period should be classified as delayed union

Advantages of external skeletal fixation are (1) firmer immobilization than that provided by a plaster cast, (2) maintained function of all joints, (3) ease of inspection and treatment of wounds or other soft tissue



Fig 7 Case 7 Aged 37 Third fragment required 2 screws at different angles external fixation, 119 days solid union, 103 days weight-bearing 119 days disability 133 days.



complications. Many simple oblique cases can be fixed adequately with a screw across the fracture line and a plaster cast, but there is always the danger that movement inside the cast will produce a fracture at the site of the screw Accidental or partial weight bearing is tolerated better by patients immobilized with external fixation than with a cast. For some comminuted fractures, screw fixation internally is not strong enough to allow the leg to be lifted safely for application of a cast. A long slotted plate would be much safer internal fixation if a cast were to be applied postoperatively in place of the skeletal fixation.

The use of external skeletal fixation has many obvious advantages for immobilization of compound fractures with or without the aid of internal screw fixation, because the wound and other soft tissue are exposed for inspection and treatment without disturbing the fixation apparatus

## CONTRAINDICATIONS

Simple undisplaced fractures in adults and most uncomplicated tibial fractures in children that can be treated with a leg cast should not be submitted to surgery The use of intramedullary pins may be a preferable method of fixation for transverse or "step fractures," if the surgeon is experienced in this method of treatment. Our limited experience with intramedullary nails in transverse tibial fractures has been very encouraging. Some simple spiral fractures with no secondary fractures or fragments may be firmly immobilized with internal screw fixation alone or supported with a non-weight bearing cast.

The use of external skeletal fixation is contraindicated in any patient if the surgeon is not familiar with the proper pin sites as outlined by Junkin* and is not willing to spend the necessary time and effort to drill pins in slowly to avoid thermal necrosis Proper postoperative care is also essential for good results Good surgical technic is as important in applying external fixation as it is in internal fixation and open reduction A certain amount of mechanical judgment must be used to place the coupling units and bars for adequate fixation without torsion or angulation All coupling units should be turned up snugly with fingers before tightening with a wrench

## COMPLICATIONS

The authors have had no cases of osteomyelitis at the pin sites Some cases had pin seepage from soft tissue tension or movement around the pins. All pin sites healed soon after the pins were removed No osteomyelitis was encountered at the site of fracture and no secondary operations were necessary in either group of cases One case in the second group mentioned above was classified as a "delayed union" because of circulatory deficiency below the knee

## SUMMARY

Open reduction is necessary for many tibial fractures to obtain an accurate reduction and a good contact. Compression and improved immobilization can be obtained by placing screws across the fracture lines of oblique or comminuted fractures The combined use of internal fixation with screws plus external fixation with Roger Anderson pins resulted in a shorter period for union to take place and a shorter period of disability than with fractures treated with closed reduction and external fixation alone Several advantages of external pin fixation compared with single casts or a cast applied over Steinmann pins have been discussed. The method is useful in properly selected cases, if the operator follows the primary principles of pin technic and postoperative care

## Uso Combinate de Externe Fixation Skeletal e Interne Fixation a Vites in Fracturas del Diaphyse Tibial

*Summario in Interlingua*

Sexanta casos de aperte o clause fractura tibial esseva immobilisate con externe fixation skeletal Omne casos esseva characterisate per comminution o marcate displacimento Trenta del casos esseva reducite sin operation aperte In illos le duration median del invaliditate esseva 170 dies Le secunde serie de 30 casos esseva etiam immobilisate con externe fixation skeletal sed le reduction esseva effectuate per medio de un operation aperte In iste secunde serie un o duo vites esseva placiate a transverso le lineas del fractura pro assecurar un fixation additional del fractura Le duration median del invaliditate in iste serie esseva reducite a 127 dies. Le periodo requirite pro le disveloppamento de un union sufficiente pro le supporto de peso esseva 114 dies, comparate con un periodo correspondente de 146 dies in le prime serie

Le externe fixation skeletal permitte un immobilisation plus firme que un apparato ingypsate illo rende possibile le tractamento e le inspection de vulneres in texito molle illo non impedi le movimento del genu o del cavilla e illo non necessita le suspension del gamba supra le tabula pro le application del gypso

Le periodo de curation esseva reducite in le secunde serie proque le reduction aperte resultava in un plus precise alineamento del fragmentos Le interne fixation a vites permitteva un plus firme apposition del su[illegible]cies fracturate e etiam reduceva le mobi[illegible] al sito del fractura.

* Junkin, H D The topography of pins, precision pinning of fractures Indust Med. 13 387 1944

# 18

# Osteoarthritis of the Hip in Gorillas

## Report of Two Cases*

H W Y TAYLOR B Sc, M B, Ch B,

J B KING, M D, F R C P.E, F F R

AND

ROBERT M STECHER, M D

Osteoarthritis of the hip is a common disease in the human but its occurrence in the gorilla is not well known Our interest in this disease was aroused on seeing it in a gorilla skeleton on exhibition in the Anatomical Museum of the University of Edinburgh. Examination of the Todd Collection of gorillas—91 skeletons belonging to the Western Reserve University Medical School in Cleveland—revealed another identical example of this disease The present study consists of descriptions of these two skeletons and a discussion of the changes found

According to the daybook of the Anatomical Museum of the University of Edinburgh, the articulated skeleton of the gorilla was obtained by purchase in 1889 and presumably it has been on exhibition since then The Museum Catalogue lists the specimen as *Gorilla Troglodytes Gorilla* and states that it consists of the complete skeleton of an adult gorilla. An identifying note adds that there is "rheumatoid arthritis" of the left hip and the left knee This diagnosis conforms to the terminology in use at the time. It is recalled that Garrod,[3] in his original suggestion of the term "rheumatoid arthritis" stated that the classical examples were characterized by Heberden s nodes and morbus coxae senilis such views are no longer tenable No bony lesion of the left knee to support this diagnosis is noticed

The skeleton is that of an adult male gorilla macerated, articulated and mounted in a standing position. All the epiphyses are completely united, those for the crests of the ilia and the ischial tuberosities still being indicated by fine lines The posture is a forward stoop accompanied by flexion of the hips and the knees so that the extended fingers reach to within 3 inches of the ground.

The skull and the dentition are typical of the adult male gorilla. There is no evidence of caries or of pyorrhea. The vertebral formula is C7 Th13 L4 S5 Co2 and there is no evidence of abnormality or disease of the spine or the bones of the upper limbs The spine of the left scapula has been damaged and the greater part of it replaced by a wooden replica The left humerus exhibits an extensive comminuted fracture pronounced by Dr F S Fiddes, of the Department of Forensic Medicine of the University

* From the Anatomical Museum, University of Edinburgh, and the Department of Medicine of Western Reserve University at City Hospital Cleveland, Ohio

of Edinburgh to be typical of the wounds produced by the large ball shaped bullets formerly used.

It is noteworthy that there is no sign of healing in this extensive fracture wound The bullet had entered the shaft of the bone through a well-defined opening on the anterior surface, about 4 inches from the anatomic neck, and had passed out through a large irregular opening on the posterior surface

The Todd skeleton is that of an adult male gorilla, macerated but not articulated All epiphyses are completely united, and all epiphyseal lines are obliterated except those along the crests of the ilia. Since the epiphyseal lines of the ischial tuberosity have been effaced, it can be assumed that this gorilla is slightly older than the one in Edinburgh. The skull and the dentition are typical of the adult male There is no evidence of caries or pyorrhea The vertebral formula is C7 Th13 L4 S5 Co2 and there is no evidence of abnormality deformity or disease anywhere in the skeleton except in the left hip joint.

The osteoarthritic changes in the hip joints of these two gorillas are so nearly alike that they can be described together The diseased acetabula and upper ends of their femurs show typical changes of advanced osteoarthritis Photographs, roentgenograms and outline drawings show the degrees of deformity and destruction present. Measurements of the acetabula and the femora, both diseased and normal, are shown in the table The diseased acetabula are larger the rims are deeper, and the floors are displaced laterally from the wall of the pelvis. The fossae are from 0.5 to 1 cm medial to the internal rims of the articulating surfaces of the acetabula instead of being flush with them as they

MEASUREMENTS

| | EDINBURGH GORILLA | | TODD GORILLA | |
|---|---|---|---|---|
| | *Right* | *Left* | *Right* | *Left* |
| **ACETABULA** | | | | |
| Transverse diameter of brim | | | | |
| Inner lip | 5.5 | 6.3 | 5.5 | 6.5 |
| Outer lip | 6 4 | 7.3 | 7 0 | 8 0 |
| Vertical diameter of brim | | | | |
| Inner lip | 6 1 | 7 1 | 5.5 | 7.5 |
| Outer lip | 6 1 | 8.3 | 6.5 | 8.5 |
| Lipping of brim | nil | prominent | nil | moderate |
| Thickness floor of fossa | opaque | translucent | opaque | translucent |
| Depth fossa below joint surface | 0.5 | 1.5 | 0 3 | 1 4 |
| Distance—joint surface to inner wall of pelvis | 1 0 | 1.5 | 0.8 | 1.5 |
| Erosion of joint surface | nil | moderate | nil | marked |
| Greatest width of joint surface | 3 0 | 4 8 | 3.5 | 4.5 |
| Projection of acetabula | | | | |
| horizontal | 90 | 75 | 90 | 90 |
| vertical | 110 | 100 | 120 | 120 |
| **FEMORA** | | | | |
| Length—to top of head | 39 6 | 38 6 | 37 | 35.5 |
| to top of trochanter | 39 6 | 39 6 | 38 | 37.5 |
| Angle neck to shaft | 120 | 100 | 120 | 95 |
| Smallest diameter of neck | 2.8 | 3 7 | 2.7 | 3 1 |
| Diameter of head | | | 5.2 | 6.2 |

Fig 1 (*Cont* ) The heads of the femora photographed from the front. The right femur is normal The left shows flattening of the upper border and enlargement of the head so that the joint surface extends lateralward half again as far as it does on the right. It also extends distally and laterally to curl over the neck. The joint surface is irregular and pitted The neck of the femur shows coxa valga



Fig. 1 (*Cont* ) Roentgenogram of the left femur showing head, neck and upper portion of the shaft. Cyst formation is seen in the vicinity of the joint surfaces.

in size and shape, are smooth and evenly rounded, and their contoured edges finish flush with the slight flaring of the neck When each pair of greater trochanters and the shafts are superimposed it is seen that the base of the left neck is apparently normal the middle region is slightly deviated, and the subcapital portion is absorbed The measurement of the angles of the necks on the shafts are shown in the table indicating a significant degree of coxa plana

Macroscopic pathology of the diseased femora shows that parts of the heads and the necks have been destroyed followed by ebur

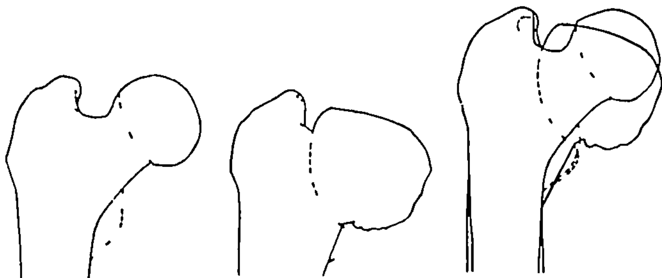


FIG. 1 (*Cont.*) Outline drawings of the heads of both femora. The drawing of the left femur has been reversed for easy comparison with the normal one In the third figure the drawings have been superimposed for easy comparison

nation or erosion of articular cartilage and underlying bone Repair has occurred by the production of degenerated granulation and spurs pitted in some places sclerosed in others and weakened by cyst formation these changes being prominent at the periphery of the enlarged heads. It is obvious that these changes in the shape of the femoral heads were accompanied by similar changes in the acetabula to broaden out, thus making the articular surfaces broader and deeper than normal.

An interesting anomaly is found in the sacrum of the Todd gorilla, namely lumbarization of the first sacral vertebra This portion of the sacrum has not fused with its neighbor and was completely free in its macerated condition. There is close approximation of the adjacent surfaces of the vertebral bodies themselves and of the lateral processes on each side S1 possesses a spinal process of normal size and shape and normally formed intervertebral joints are present between S1 and S2 The rest of the bodies of the sacrum are separated from each other across their anterior surfaces There is also lack of fusion of the anterior surfaces of the lateral processes on both sides between S2 and S3 No sign of separation remains on the posterior surface between S2 and S5

## DISCUSSION

The skeleton of the Edinburgh gorilla was purchased in the year 1889 It is known that as a rule the Zoological Gardens in Great Britain and in Europe generally did not house adult male gorillas previous to the year 1900 This fact, along with the presence of a large unhealed wound of the bone, suggests that the animal probably was shot dead under natural conditions

As age is an important factor in arriving at a correct diagnosis of the kind of disease present in human bones it is interesting to note that this gorilla was apparently adult but not senescent. The state of the epiphyses the healthy well formed appearance of the vertebrae and the bones in general, except for the left hip and the condition of the teeth—erupted but not unduly worn—all point to the conclusion that the animal was in good health and possibly vigorous in spite of the osteoarthritis On the other hand, S K. Basu,[1] who examined a collection of 41 adult gorillas, described this as "an old adult." He based his opinion on Krogman's[6] method of correlating the age of the animal with the sequence of erupted teeth in this way a division of 6 "dental groups" was formed, each group being regarded as a convenient formula for "dental age "

The Todd gorilla was found in the Todd Collection of Western Reserve University Medical School. This consists of 91 skeletons obtained in Central Africa by missionaries They attended the native gorilla hunts and barbecues, collected the bones stripped the remainder of the flesh away packed them in gunny sacks and shipped them to Cleveland, where the final job of maceration was completed. This Collection was made over a period of years Part of it at least was examined by Fox[3] because he has notes on 12 gorillas but this case was not noted.

This specimen described as B 1717 is listed as adult without further comment as to age It is slightly older than the Edinburgh skeleton, because the epiphyses of the ischial tuberosities have become completely fused. As judged by the epiphyses of the crests of the ilia which are both present as lines both individuals were in young adult life This view is supported by the fact that the teeth have not been worn down. There is also no evidence of spur formation or osteoarthritis elsewhere in either skeleton.

This study is concerned with the skeletons of 2 male young adult gorillas one now in Edinburgh the other in Cleveland each with

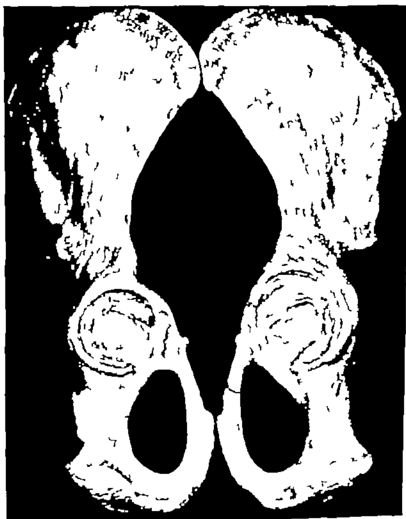


FIG 2 (Todd gorilla) Photograph of both pelvic bones showing the acetabula. The right acetabulum is normal the left is enlarged, the joint surface has grown medialward to cover about one third of the area of the fossa, and it is elevated above it, leaving a pocket between the fossa and the joint surface

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FIG 2 (*Cont*) Anterior view of both femora. The right femur is normal. The left femur shows coxa vara the joint surface is enlarged it has moved caudalward and turned forward Its shape has become flatter and more nearly cylindrical.



FIG. 2 (*Cont*) Posterior view of both femora The right femur is normal. The left femur shows more clearly the coxa plana, the shortening and the thickening of the neck, the change in shape of the head and the change of position of the joint surface from its posterior position to the anterior position This suggests that the leg was held in internal rotation to keep the joint surface in contact with the acetabulum The rolling of the edges of the joint surface also is shown

well-defined and undoubted osteoarthritis of the left hip There is no evidence of other disease deformity or anomalies of the skeletons. Of course no history is available, so it is possible only to speculate upon the clinical history Nevertheless it may be possible to arrive at a fairly accurate diagnosis

The cause of osteoarthritis of the hip varies considerably from developmental defects to trauma and constitutional disease At times it seems to arise spontaneously without recognizable cause. In considering these gorillas some of these possible causes can be safely excluded. There is no reason to consider fracture of the neck of the femur because no deformity suggesting these events remains Traumatic subluxation of the hip may be dismissed, because no means were at hand to reduce such a deformity Severe injury with fracture of the joint surface also can be dismissed, because no small piece of detached bone was found, nor was there a bed on the joint surface from which it might have been separated.

Congenital dysplasia of the hip seems to

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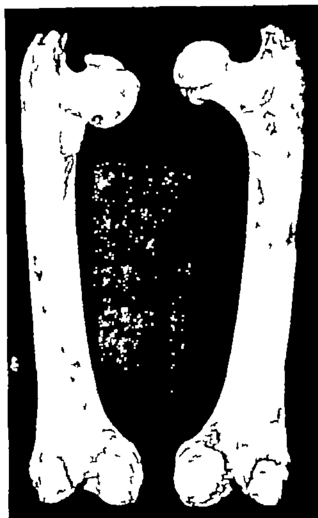


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FIG. 2 (*Cont*) Superior view of both femora. The joint surface is enlarged and flattened its edges roll over the neck, and large areas of erosion of the joint surface are seen. The loss of cortex in the right femur is due to an artefact.

be an unlikely possibility The acetabula are large and well developed, each has a sturdy roof and is of normal depth, and no erosion is seen of the upper border In humans congenital dysplasia has been described as being 6 times as common in girls as it is in boys It affects the left hip 1½ times as commonly as it does the right, as stated by Hass.[5] Both of these animals are male and the hips involved were the left in both instances. The fact that the Cleveland gorilla showed incomplete fusion of the sacrum might be used to support the diagnosis of congenital dysplasia, since both conditions indicate a lack of completed development. The sacral anomaly must be considered an independent event of no significance to the hip disease

The roentgenographic observations made on the Edinburgh gorilla narrow the issue down to two possible causes and point to one of these as the probable determining factor When the overlay of chronic degenerative changes is as marked as in this case it is rare for dogmatic speculation about the primary cause to be justified But, because the relative maximal widths of the right and the left femoral necks are 3 7 and 4 8 cm respectively there can be little doubt that the original lesion was a true osteochondritis of the femoral epiphysis (Legg-Calvé Perthes disease) The deformity of the head supports this finding

It remains just possible that it may have been a partial epiphyseal slip with over growth of the neck, perhaps, in the preslip stage of metaphysical, hyperemic decalcification. The relative depth and distribution of sclerotic eburnation and rarefaction is very much that to be expected in a human case of unilateral osteoarthritic hip disease.

This condition occurs most often in young boys who are overweight and show poor or retarded sexual development. The slipping of the epiphysis has been observed to occur in patients in whom the epiphyseal line is broader than normal Hackenbroch[4] states that distinction between these two causes is difficult or impossible from examination of the middle aged patient with well-developed osteoarthritis a view which is reiterated by Lloyd Roberts.[7] Also osteoarthritis has been seen to develop in a hip previously normal without injury infection or other recognizable cause by one of us (R.M.S )

Whatever the causes, the deformities of these hip joints were considerable and function must have been impaired. Range of movement was no doubt reduced and the animals limped. Physical impairment did not prevent apparently normal growth and development. There is no telling how much if

any it may have interfered with these animals activity It may have handicapped them sufficiently to allow them to be shot and captured.

The extremely gross degenerative condition found in one hip joint in these gorillas must be regarded as secondary to a monoarticular lesion during the period of bone growth and should not be accepted as demonstrating the existence in these gorillas of a disease entity such as is commonly understood by the term osteoarthritis when applied to polyarticular senescent degenerative arthritis in human beings.

We wish to thank Professor J C Brash for permission to publish this account of the Edinburgh gorilla and also for his generous assistance in its preparation For the preparation of the photographs and the roentgenographic prints grateful acknowledgement is made to Mr John Borthwick of the Anatomy Department of the University of Edinburgh We wish to thank Dr Normand L. Hoerr Henry Willson Payne Professor of Anatomy of Western Reserve University School of Medicine for permission to examine the Todd Collection of gorillas and to describe one of them

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## Osteoarthritis Coxal in Gorillas

### *Reporto de Duo Casos*

### *Summario in Interlingua*

Es describite le skeletos de duo gorillas mascule ambes con sever osteoarthritis del coxa sinistre Omne le altere articulationes es normal Le lesiones in le duo animales es multo simile

Es discutite le causa probabile de iste osteoarthritis, con le conclusion que ambe casos resultava probabilemente de morbo de Perthes, sed le possibilitate que un curate displaciamento epiphyseal esseva de signification etiologic non pote esser definitivemente rejicite Il es probabile que le osteoarthritis in iste casos non resultava de fracturas del capite femoral, de traumatic dislocationes coxal, o de dysplasia congenite

Le duo casos es exemplos de osteoarthritis monarticular in adulte sed non senescente gorillas mascule Un del skeletos es exhibite —apparentemente depost 1889—al Museo Anatomic del Universitate Edinburgh Le altere pertine a un gruppo de 91 skeletos de gorillas in le Collection Todd al Schola Medical del Universitate Western Reserve a Cleveland.

# 19

# Detection of Chordoma

## Report of Four New Cases*

ALBERT LANHAM ALLEN, M D †

There is a paucity of chordomas as Samuel Johnson said concerning the trophies of fox hunting. Of late instances of the tumor have been reported avidly [2,3,9 12]

Mabrey[6] culled 150 chordomas from the literature up to 1935 and since then the collection of cases has accelerated somewhat. Still, the recorded incidence of chordoma does not exceed 350 known lesions since Virchow first held in his hand a small bubble-bearing excrescence from the sphenoid, now a hundred years ago

To delineate chordoma completely is not within the scope of this effort. The aspect *of pathology for example with its ultimate* findings is omitted here altogether The slides confirming 4 original cases have been analyzed with care and for thorough histologic study the reader is referred to the treatise by Dahlin and MacCarty[3] Other sources of information appear in the appendage For review of individual cases, with historical and other details there are available articles by Poppen Gentil and Ernest Wood.

## DESCRIPTIVE DATA

With pardonable stereotypy chordoma may be defined as a malignancy springing from residua of the chorda dorsalis Small masses representing normal outgrowths from the notochord have been found along the spheno-occipital synchondrosis in 1.5 per cent of postmortem examinations These slippery gelatinlike particles are not malignant and are not chordomas they remain unchanged in the life-span of the individual. Actually it was this jellylike substance—ecchordosis physaliphora — which Virchow depicted historically Two years afterward (1858) Muller suggested its real origin.

It is perhaps best to regard chordoma as a tumor arising from unnatural notochordal remnants—vestiges that have remained abnormally These residua later undergo malignant change after the manner of embry*onal rests as exiled tissue in foreign soil,* and thus may be termed heterochthonous[5] Normal remnants of the chorda, the inter vertebral disks never have been the site of malignant growth.[10] First described by Trélat in 1868[7] the features of chordoma were elaborated and classified in 1894 by Ribbert

Chordoma may occur anywhere along the course of the old notochord from the sphenoid to the coccyx. Age incidence varies from 7 months to 82 years[10] Convenience and custom have divided this entity into the more common sacrococcygeal the less com

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* Read before the Russell A. Hibbs Society Seventh Annual Meeting, Huntington, W Va., April 30 1954 Appreciation is expressed for permission to use the following cases to Dr Joseph E. Bell Louisville, Ky., for Case 3 to Drs. F L. Coffey and T J Holbrook, Huntington W Va., for Cases 1 and 4 respectively to Dr J M Keeton Ashland Ky., for Case 2.

mon cerebral or spheno-occipital and the very rare spinal tumors The growth of this cancer is slow and remorseless seldom metastasizing it extends by invasion and finally presses the life out of vitals. This exquisite faculty for infiltration is strange for grossly chordoma appears as a baggy kind of tumor and under the microscope it is more remarkable still Cytoplasm and even nuclei show secreting vacuoles and the cells appear to lie in their own cesspool of mucus

Irradiation does not alter the form or change the course of this tumor[10] Surgery is the only effective treatment and, except for vertebral lesions usually proper excision cannot be done Involvement of essential structures prevents dissection hence the clivus and sacral chordomas are fatal invariably From operation or metastasis, a few victims go quickly others linger wishing that they were gone The average rate of survival is 30 months from the onset of symptoms[6]

## IMPROVED CLINICAL DIAGNOSIS

In this chapter interest centers on the clinical detection of chordoma. Successful diagnosis of the new growth before exploration today is a far cry from the status of even 2 or 3 decades past.

As late as 1948 *Gentil and Coley* put the proportion of accurate preoperative diagnoses at 10 per cent, but the estimate was based on tabulated chordomas which dated over an extended interval[3] Pendergrass[8] states for example that the percentage of roentgenographic impressions in instances of chordoma proved to be correct in his department is now altogether high This represents great change from the position taken in his text (1940) where he quotes Adson as authority[7] and says, with wry humor that respecting chordoma the roentgenologist had best leave the diagnosis to the clinician. The comparison is intriguing, for improved roentgenographic technic with greater use of films has contributed more than any other factor to the increase in preoperative diagnosis of chordoma Technics needless to say, are worthless *in themselves without the concerted* action of the orthopaedist, the neurosurgeon and the radiologist, or without their combined skill and acumen. My colleagues or myself either included the lesion in the differential diagnosis or designated the tumor outright before biopsy in 3 out of 4 chordomas presented[3] Cases occurred within an interval of 2 years, and in a tristate population of 150,000

### SACROCOCCYGEAL

Incidence Over half of all chordomas have been found in the sacrum—10 per cent over A good proportional estimate is 60 per cent for sacral 25 to 30 per cent for cerebral and 5 to 10 per cent for vertebral tumors As before intimated any age group or sex is liable but male instances preponderate, and occurrence is less frequent prior to puberty

Symptoms. Without exception there is a history of pain. This sensation is dull and *aching, with feeling of pressure in the pelvis*, but often there is a sciatic distribution as in ruptured disk. The syndrome is what would be expected with a mass in the posterior or mid pelvis It always includes constipation, and usually bladder disturbances and neurogenic phenomena. The intensity of the symptoms varies with the duration and the rate of growth of the tumor

Diagnosis. A mass is palpable on examination. Chordoma is a presacral tumor but it may extend in any direction. Commonly it is discovered at its site of origin and usually when located elsewhere about the sacrum it is found to be presacral as well.[3] It is best felt on rectal examination, with the palpating finger directed backward. When chordoma cannot displace it invades if extending posteriorly it pierces the bone and appears as a lump beneath the skin over the sacrum—as in 1 of our cases—as large as a goose egg There is displacement rather than invasion of the bowel though from pressure there is narrowing of the bowel lumen.

ROENTGENOGRAPHY Other than biopsy of chordoma, roentgenography is the only laboratory procedure of aid. The films show destruction of bone in sacral chordoma almost without fail, and Gentil and Coley made the diagnosis by roentgenography in 4 out of 7 cases[3] Malignancy of the chorda dorsalis is the most frequent tumor showing roentgen evidence of primary invasion of the sacrum.[1]

The changes seen on film examination consist of (1) calcification (2) osteolytic destruction and (3) thinning and expansion of bone

DIFFERENTIAL DIAGNOSIS

1 Metastasis to the sacrum with pure osteolysis is the most frequent cancerous invasion of this structure seen in everyday practice of radiology An occasional chordoma may mimic secondary metastatic spread, and distinction must be made on a basis of clinical knowledge and history of the case

2 Sarcoma of the sacrum especially chondrosarcoma, may give difficulty Sarcoma usually affects adjoining bones as well as the sacrum moreover it lacks the bulky mass seen in chordoma, at least until well advanced—long after biopsy has been done

3 Teratoma in infants and children may be confusing. This tumor occupies the same position as chordoma and presents posteriorly over the sacrum as does meningocele Occasionally seen by the consultant in adults, teratoma shows deposits of calcium which are said to be characteristic.[4] However there is actually no osseous invasion of the sacrum, and careful filming should enable the interpreter to distinguish

4 Carcinoma of the rectum particularly colloid or mucinous carcinoma bears both a clinical and a pathologic resemblance to chordoma Both may cause bleeding (the chordoma from pressure either directly or indirectly from varices) but hemorrhage in chordoma occurs at a late stage. Moreover the history indicates a slow growth generally for chordoma and a more rapid development for rectal carcinoma In new growth of the rectosigmoid there is lacking the symptom of disklike sciatic pain. Studies by x ray should finally differentiate since metastases to bone from carcinoma of the caudal gut are distant almost always and not likely to involve the sacrum

5 Tuberculosis of the sacrum is perplexing without a chest roentgenogram, and I have seen 1 such case

6 Rarely plasmacytoma, limited to the sacrum, bewilders the radiologist, but since plasmacytoma lacks the large soft tissue mass present in chordoid tumor physical examination serves to differentiate

Thorough study by both orthopaedic surgeon and radiologist together should provide the diagnosis of sacrococcygeal chordoma before surgical interference Then confirmation should be obtained by direct or aspiration biopsy or by exploration.

Case 1 J B white female aged 11 Symptoms were those of constipation for an indefinite time with marked increase in severity within the past year and pain with sciatic distribution, growing gradually worse The patient was free of other symptoms and the history was essentially negative.

On examination a hard egg-shaped discolored mass was noted over the sacrum and was found to be presacral on rectal palpation. Other findings, including laboratory were not contributory A tentative diagnosis of teratoma was made, and roentgenograms were taken of the pelvis (Figs. 1 and 2) The roentgenologic diagnosis was chordoma, with no differential given (the author)

Aspiration biopsy was not satisfactory After some delay the patient was hospitalized surgical biopsy was carried out, and the diagnosis of chordoma was confirmed (Dr S Werthammer Pathologist, St. Mary's Hospital, Huntington W Va.) Block dissection was contemplated, but the patient was removed abruptly to her home and was not seen again. She was reported to have died after a few months, presumably in uremia.

Case 2. Mrs. S M., white housewife, aged 19 History Chief complaint was that of severe constant and agonizing pain in the lower back radiating to both legs—worse on right. For 9 months there had been increasing weakness,

tion of the unresectable lesion were removed. A colostomy was done.

Subsequent studies of the sections proved that the lesion was chordoma.

The course of the patient was downhill. She developed jaundice and died 5 weeks following operation.

SPINAL CHORDOMA

Of the vertebral chordomas, cervical involvement is the most usual and lumbar is next in frequency Location in the thoracic division is extremely uncommon Taken all together vertebral chordoma constitutes less than 10 per cent of these tumors Spread of the lesion takes place through the vertebral body, the pedicles the laminae and even the spinous processes before impinging on the cord.[9]

Clinical and neurologic signs of vertebral chordoma are not pathognomonic, resembling those of tumor generally

Roentgen evidence usually of bone is present and indicates neoplasm, but findings are not specific Osseous changes may be classified as (1) osteolytic resembling metastasis and most common (2) sclerosis of bone often misinterpreted by the radiologist, and (3) a rare honeycomb or cross-striated appearance resembling hemangioma of the vertebra Soft tissue swelling may be seen in the absence of bone invasion. Myelography is neither characteristic nor helpful in differentiating the tumor; in early or sluggish chordoma, the myelogram may be within limits of normal, while in late or rapidly growing lesions there is evidence of cord compression or even spinal block. Attempt at roentgenographic differentiation of cord tumors has been made (see Tabulated List) but preoperative diagnosis of vertebral *chordoma remains good guesswork only*

Case 3 W H., white, male age 40 industrial worker The chief complaint was that of low backache of 2 months duration with typical disklike distribution on the right. AP and lateral films of the lumbosacral area were taken but were reported by the original interpreter as within normal limits. Patient's symptoms increased, and he returned for further examination when follow-up roentgenograms were taken revealing the lesion (Fig 3) Physical examination and additional history not pertinent in this connection.

ROENTGENOGRAPHIC APPEARANCES OF SPINAL TUMORS

| *Type of Growth* | *Roentgenographic Changes* |
|---|---|
| 1 Chordoma | Massive erosions of sacrum and destruction of laminae and spinous processes margins irregular and not well defined. |
| 2 Dermoid (sacrum) | Localized erosions in body of sacrum sparing spinous processes and laminae |
| 3 Hemangioma | Irregular absorption of trabeculae thickening of remaining vertical trabeculae parallel vertical striations in body widening of intertrabecular spaces, arches and laminae may be involved. |
| 4 Neurofibroma | Thinning and erosion of medial border of vertebral pedicle at site of growth later of both pedicles and laminae, with destruction of those on the tumor side if extruding through foramen, the latter will be enlarged. |
| 5 Ependymoma | Sharp and well-defined margins where it erodes bone anywhere round lumbosacral canal. |
| 6 Endothelioma | Similar but it never extrudes through intervertebral foramen calcified particles may occur within it. |
| 7 Primary sarcoma | Dissolution and destruction of bone secondary affection of juxtavertebral soft tissues. |
| 8 Malignant, metastatic (carcinoma hypernephroma myeloma, lymphoblastoma, etc ) | Characteristic rarefaction and dissolution of bony tissue diffuse, irregular vertebral collapse |
| 9 Intramedullary (glioma) | Very rare and only when cord is so expanded as to press on and erode laminae, pedicles, or bodies |

Tabulated List (after Camp and Adson, rearranged. *Cited by Wilson.*[11])





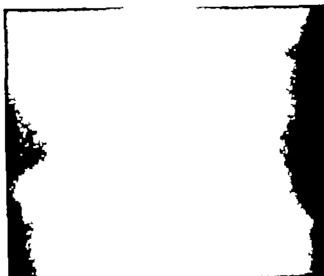


FIG 3 (Case 3) (*Left top*) Anteroposterior view barely shows neoplasm of body of L-4 When observed the new growth appears to be over pedicular area on right. The lesion was missed by the first examiner who had access to anteroposterior and lateral projections only (*Right top*) Oblique view showing to advantage rarefied or osteolytic effect of chordoma involving body of L-4 and emphasizing value of oblique views. (*Right bottom*) Lateral postoperative roentgenogram. Here the affected vertebral body is overcast by the crest of the ilium, and the lesion is obscured further However the honeycomb pattern is faintly suggested (cf illustration of Schinz *et al* [11]) From this single lateral view the lesion might be mistaken for hemangioma of the vertebra.

Aspiration biopsy indicated questionable chondrosarcoma. Review of slides resulted in final diagnosis of chordoma (among reviewers was Doctor Jaffe of New York City) Patient received irradiation, returned to his job in light duty status and has remained well for 1½ years.

## Spheno-occipital Chordoma

Chordoma of the occipital synchondrosis accounts for slightly more than a fourth of the collected tumors. This entity should be considered in any neoplasm involving the floor of the skull.

Beginning as a mid line lesion, sphenoid chordoma shows the same invasiveness as seen elsewhere It presses in any direction, dissolves bone and affects any or all of the cranial nerves at the outflow level Its predilection is for the optic chiasm, the hypophysis and the sphenoid. Seldom does the neoplasm cause elevation of the spinal pressure Like other brain tumors and like vertebral chordoma, this clivus variety of cancer does not metastasize a single exception being the case of Pototsching. Yet growth is ceaseless and the course is to expand and to destroy

From this description, the symptoms can be visualized as complex, and they depend upon what is invaded. Headache as in all cerebral tumors and visual disturbances are the most frequent complaints. Spheno-occipital chordoma may give rise to syndromes simulating craniopharyngioma, pituitary tu



FIG 4 (Case 4) The lateral view of the skull shows the sella completely destroyed. Fine scattered flecks of calcification appear above and posterior to the sella. Other views (not reproduced) indicated additional destruction of the floor of the skull, especially of the clivus.

mor (with little hormonal dysfunction) acoustic neuroma, cerebellopontine angle tumors, or gliomas affecting any of the cranial nerves Most remarkable mimicry is that of nasopharyngeal neoplasm. Here the chordoma extends downward from the sphenoid sinus—occasionally without roentgen sign of bone loss—showing all the earmarks of a transitional cell carcinoma

The various cranial projections should suggest the lesion Bone destruction plus calcification again give the telltale signs Break through occurs and is seen in surrounding bone—sella, sphenoid, clivus and even the petrous pyramids These roentgen signs with calcification, are believed to be characteristic In the typical picture craniopharyngioma may be troublesome In the latter calcification is more compact and localized as opposed to the scattered deposits in chordoma in craniopharyngioma often the sella is ballooned, and when sellar invasion occurs the extent is not so great as in the average chordoma Lympho-epithelioma, arising from, but without vestige in, the nasopharynx may rarely be confusing.

Collaboration between roentgenologist and neurosurgeon should resolve the problem before exploration in most instances Final diagnosis is by exploration in the form of craniotomy or in some expert hands, through biopsy of the sphenoid sinus

Case 4. S M white male age 59 Onset began two years previously with visual difficulties. After one year of failing vision, total blindness occurred. Patient was seen in a large eastern teaching center where a diagnosis of craniopharyngioma was made Treatment was not advised.

Patient entered St. Mary s Hospital, Huntington, West Virginia, on May 3 1953 Neurological examination disclosed some degree of involvement of every cranial nerve. Most marked was optic atrophy

Skull roentgenograms showed scattered flecks of calcification above the hypophysis and extensive destruction of sella sphenoid, and clivus. The interpretation of the radiologist was chordoma (Dr H R. Crews) and this was likewise the opinion of the neurosurgeon (Doctor Holbrook) A craniotomy was done, and biopsy confirmed the impression (Doctor Werthammer)

The patient is still living a vegetable existence.

## COMMENTARY

These instances of chordoma seen in *1951 53 and hitherto unreported are quite* representative except for Case 2 Here disseminated metastasis occurred, which is unusual. Though sacral chordoma alone metastasizes (Pototsching s one experience with clivus tumor is excepted) spread even from caudal chordoma is rare Dahlin and MacCarty submit that metastasizing sacral chordoma is seen seldom and most occurrences in medical writing stem from faulty histologic findings[2]

Mention is made of the course taken by Case 3 the subject having indicated thus far no sign of deterioration Long-term survival among patients afflicted with chordoma is exceptional and limited almost entirely to the vertebral type (cf case reports of Poppen and King[6]) From the therapy perspective it is fallacy to conclude that irradiation stays the progress of chordoma There is no

evidence that the neoplasm is radiosensitive and apparent retardation of tumor growth should not be confused with tumor lethargy From a review of the annals the consensus on this topic appears to be almost uniform


## SUMMARY

1 Four confirmed cases of chordoma are contributed to the literature

2 Chordoma is uncommon though reported incidence has accelerated lately this increase is attributed to improved diagnosis and case-finding

3 There is divagation to some extent on preoperative diagnosis of chordoma including clinical and roentgenographic differential Of spinal sacral and clivus chordomas only the vertebral lacks clinical or roentgen clue to identity leaving 90 per cent of chordomas which should be designated before biopsy

4 Collaboration between better trained specialists, together with more extensive use of roentgenography is the explanation offered for more efficient clinical diagnosis today


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## Detection de Chordoma Reporto de Quatro Nove Casos

*Summario in Interlingua*

Le presente reporto de chordoma es dedicate al diagnose clinic e radiographic

Previe reportos se occupava detaliatemente del pathologia Isto es un aspecto sin importantia fundamental pro le plano del presente reporto sed omne aspectos del tumor es discutite al minus brevemente Nos adde quatro nove casos al total absolute que es numericamente parve

Solmente pauc annos retro estimationes del diagnose pre-operative de chordoma *amontava a 10 pro cento In nostre dies le* efficacia del detection de chordoma pote attinger 90 pro cento sed isto es le maximo Chordomas vertebral que representa inter 5 e 10 pro cento del lesiones total, non es identificabile ante le excision proque le varietate vertebral de iste neoplasma non possede le characteristicas que servi a differentiar lo ab altere tumores spinal. Nos presenta criterios que pote a vices servir a identificar chordomas vertebral in roentgenogrammas Nos opina que omne chordomas sacral e le majoritate del chordomas spheno-occipital pote esser identificate ante le exploration.

Ben que effortios coordinate del varie specialistas involvite es un precondition essential pro le detection de chordoma, le explication del recente melioration del diagnoses pre-operative de iste morbo es le meliorate uso de medios radiographic plus tosto que ulle altere factor



FIG 4 (Case 4) The lateral view of the skull shows the sella completely destroyed Fine scattered flecks of calcification appear above and posterior to the sella. Other views (not reproduced) indicated additional destruction of the floor of the skull, especially of the clivus.

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# Report of Two Cases of Delayed Union or Nonunion Treated by Prolonged External Pin Fixation and Impaction*

W Compere Basom M D , M Sc Or S

Fractures which do not unite readily after bone graft procedures create a very difficult situation for the treating doctor and the patient. The occurrence of these unresponsive fractures is very rare Since 1943 3 such cases of the forearm referred to the author have been treated by external pin fixation with impaction over a prolonged period with resultant bony union

The pin fixation employed was that as advocated by Roger Anderson with the use of the strong Tower pin. None of these ever has been observed to break The pins are inserted in an oblique half pin fashion above and below the fracture site Care must be taken, of course to fix very carefully both cortices of the bone with each pin The work is done in the operating room under general anesthesia Careful aseptic precautions are observed with the routine type of draping It is useful to feel for the bone as advocated, by a small Kirschner wire so that the anterior and the posterior cortices through the lateral plane can be located. Then each pin is inserted for the half pin set. The cortex on each side of the bone must be engaged by each pin which should be in mid-center in cross section of the bone The pins are driven toward each other for each half pin set so that when they are fastened externally they form very firm fixation on each side of the fracture site Then the half pin sets are connected, and strong impaction is made toward the fracture site and the several connecting bars are used for maintenance of the impaction with the fixation The half pin sets are placed approximately midway between the old fracture site and the ends of the bones or wherever the skin is fairly normal. Scar tissue is a poor surrounding area for pins and should be avoided if possible The problem is slightly different than in fresh fractures, since the direction of pull is toward rather than away from the fracture site. Therefore control of these old fracture cases is probably a little better in mid position rather than toward the ends of the bones however this is not an important point. The pins should be drilled into the bone very slowly so that no heat is created to destroy the bone and create a so-called ring sequestrum. Pin irritation has been a complication in this type of management. This is due mainly to the skin moving up and down on the pins Therefore it is necessary to fix the skin carefully This is done by using a sterile layer of dressings of gauze next to the skin around the pin usually size 2 x 2 in., since the pins are the small dental size Several layers of ¼ inch thickness of sponge rubber are applied by merely pushing the squares down

* This paper was presented at the annual meeting of the American Fracture Association at Houston, Texas, on October 14 1954

over the ends of the pin before the connecting piece has been applied Then as the connector is attached to the pin it can be pushed down against the sponge rubber to give the desired amount of pressure It is desirable to have neither too much nor too little pressure

The patient must be cautioned not to permit the dressings to become wet. One pin tract infection did occur however it disappeared as soon as the pin could be removed

It has been necessary to keep the pin traction in place for as long as 14 months in one

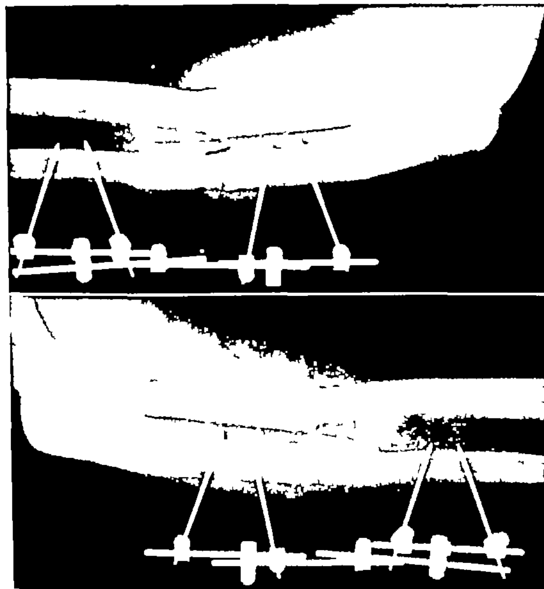


FIG 1 (*Top*) Injury—a direct blow to the forearm in service in 1943—resulted in a fracture of the ulna and the radial shafts and the head of the radius Bone-graft procedure had been done By the time the patient first was seen by the author motion still was present definitely in the ulna There was slight movement in the radial fracture site The proximal radio-ulnar joint was ankylosed with fibrous tissue There was marked limitation of the elbow and the wrist joints It was decided to use external pin fixation impacted method of prolonged immobilization Immobilization of the ulna stabilized the radius sufficiently due to the fibrous ankylosis however the patient was allowed to mobilize flexion and extension of the wrist and the elbow He was cautioned against rotating the forearm (*Bottom*) After 3 months solid union occurred.

case These 3 patients were all perfectly willing at this stage of their fracture treatment to undergo the discomfort of pins rather than submit to another bone graft procedure The bone may absorb about the pins and from time to time the pins should be readjusted and they should be loosened slightly and the impaction again applied at the half pin sets, then the connecting bars tightened in order to maintain fixation with impaction This is practically the same as the contact compression idea

Many of the old nonunion cases of various bones during surgical exploration have been found to have white chalky avascular bone at one side or the other of the fracture site The theory advanced is that the blood supply within the bone has been damaged, possibly due to thrombosis of the interosseous arterial system Therefore union cannot occur regardless of the method used. After sufficient time has passed, the bone may revascularize If it revascularizes to the fracture site it is possible that union may take place The success in these cases depends on adequate fracture fixation and immobilization

Pin fixation impaction method gives adequate and prolonged fixation and this can be carried over a long enough period of time to allow the bone to revascularize and then unite

However with the external pin fixation joint movement can be maintained The operative procedure is simple No additional bone graft material is utilized. The danger of a postoperative infection at the fracture site is eliminated. The local blood supply around the fracture site is not disturbed, which is possibly important in the obtainment of union. This external pin fixation could be used in old infected nonunions also The disadvantages are that it is difficult to obtain perfect alignment and position with this method due to old scar contracture in the interosseous space Also the apparatus is a little bulky and does require management to prevent pin irritation and to maintain the desired impaction and fixation.

## SUMMARY

In those few cases in which shaft fractures of the radius and the ulna fail to unite

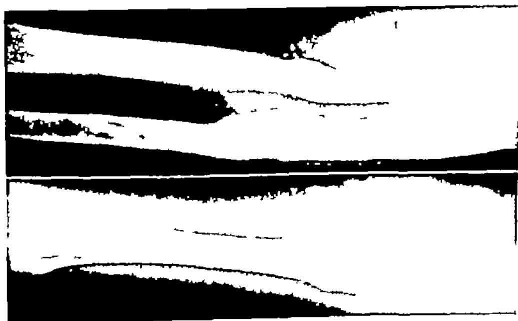


FIG. 1 (*Cont*) *The radial* head then was excised and the patient was able to mobilize rotation of the forearm. He succeeded in gaining full range of elbow forearm and wrist movements, including full forearm rotation

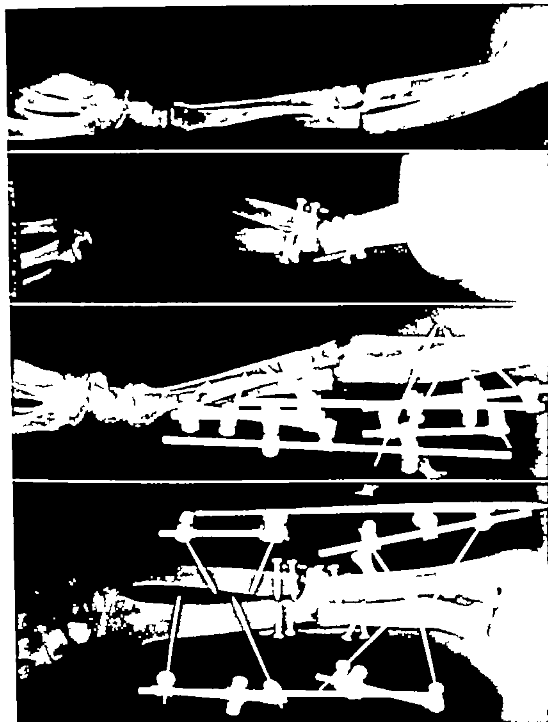


FIG. 2. (*Two top illustrations*) On May 20 1949 this patient received an open fracture of the ulna, the middle third of the forearm, and a closed fracture of the radius, the middle third of the left forearm from a severe crushing injury Intramedullary pin fixation and open reduction were utilized.

On March 7 1950 (10 months later) bone was grafted to both fracture sites, bone from the right tibia being used.

On September 9 1950 (6 months later) there was a definite failure of both bone-graft procedures however the patient had been trying to use the arm. At that stage the patient was referred to the author

(*Two bottom illustrations*) On September 14 1950 external pin fixation was applied to both fracture sites a third open reduction with plating or other type of internal fixation and bone grafting was thought to have a higher risk of infection There was quite a bit of scarring and contracture, and therefore, position of the bone fragments was secured as well as possible Actually the forearm looked much better than the roentgenograms would indicate

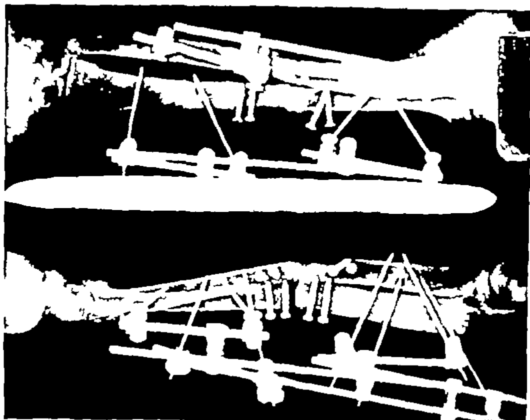


Fig 2 (*Cont*) On March 13 1951 the radius was united solidly and the pins were removed from this radius. This required 6 months after the insertion of the external pins The ulna fracture site seems to be bridging The pins were adjusted from time to time in an attempt to gain better alignment and apposition This was done easily at the office and also it compensated for the slight loosening of the pins and absorption

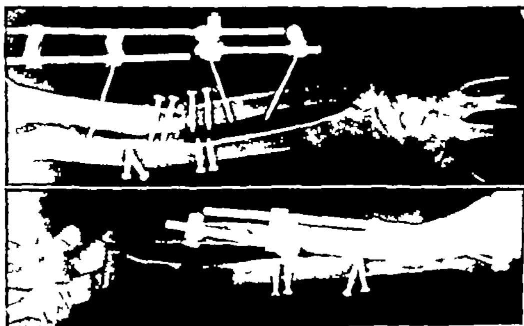


Fig 2 (*Cont*) On November 14 1951 8 months later or 14 months after pin insertion the ulna fracture site was found to be united solidly and the pins were removed.

after bone graft procedures prolonged fixation and impaction by external pins can be considered The pin technic application has been mentioned and should be followed carefully In the 3 cases referred to the author treatment with this method resulted in osseous union Some of the advantages and the disadvantages have been mentioned Adequate follow up work both clinically and roentgenologically is of the greatest importance Fixation impaction should be maintained until by roentgenologic means osseous union of the fracture site can be definitely proved

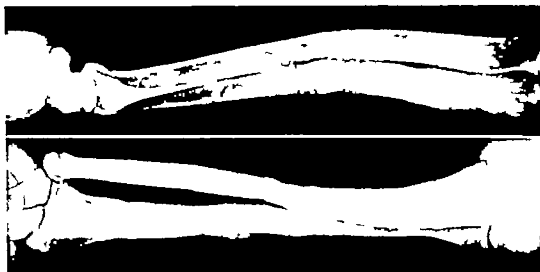


FIG. 2 (*Cont* ) The screws became prominent, and, therefore, the patient agreed to their being removed. This procedure was carried out on December 28 1951 On February 22 1952, when this roentgenogram was made there was good progress. Rotation of the forearm was found to be 50 per cent of normal, the appearance of the forearm was good and the patient was pleased with the result. Follow-up examinations were carried out through October 1952 with continuation of roentgen evidence of union with good function The patient returned to full activities Functionally he had practically no disability

This is presented mainly to show that prolonged fixation with impaction over a long enough period of time will aid in the production of union

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## Reporto de Duo Casos de Union Retardate o de Non union, Tractate per Prolongate Fixation a Spinulas Externe con Impaction

*Summario in Interlingua*

Le union de certe fracturas del diaphyse del ossos antebrachial pote esser promovite per un prolongate fixation externe in combination con impaction per le si appellate "compression a contacto" Le fixation se effectua per medio de spinulas externe del typo Tower a parve dimensiones dental. Per iste methodo le articulationes cubital e carpal non es immobilisate sed un firme fixation con compression pote esser mantenite

Nos presenta un delineation del technica de mantener le spinulas e evitar irritationes cutanee Le apparatura es satis facile a applicar Etiam su mantenentia durante le periodo del tractamento non es difficile.

Como explication de iste typo de non-union o union retardate nos presenta le theoria que il se tracta de un serie impedimento del apporto de sanguine in le osso On trova que in tal casos le osso es dur e blanc e avascular a un o ambe lateres del sito del *fractura* *Si le fixation con compression a* contacto e impaction pote esser continuate usque le intra-ossee systema vascular ha recuperate ab le effectos del lesion e usque le osso es revascularisate alora il es probabile que *le union va effectuar se* *Spinulas* externe offere un methodo que rende possible le application del supra mentionate principio a casos recalcitrante

# 21

# The Diabetic Foot

William L Lowrie, M D,* W Earl Redfern M D†
and Brock E Brush M D‡

Since the advent of the antibiotics with their great modifying effect upon infection, several surgical principles of long standing have had to be re-evaluated With the control of infection major amputations which previously were the rule for diabetic foot complications, become less urgent and in many patients are avoidable Local foot surgery has become practical and has resulted in the salvage of many limbs Antibiotics have removed the risk of this conservative attitude in the treatment of diabetic infection and gangrene The status as a wage earner the condition of the other leg of the vessels generally and the general health are factors which remain to be considered when the treatment is being outlined

As diabetics succeed in living with their disease for 20 or more years an increasing number develop a severe degree of atherosclerosis This is in part a result of survival into the age group in which atherosclerosis is present in the nondiabetic and in part due to the known tendency for long-standing diabetics to develop arteriosclerosis

Arteriosclerosis of the lower extremities has increased the incidence of diabetic foot complications including gangrene and infections As experience accumulates in handling these complications it is found that lesions which at first might seem to be hopeless can often be treated conservatively without surgical amputation We feel that most cases should be given at least a trial of conservative therapy In a few cases amputation will be necessary later because of intractable pain, extensive tissue destruction or too great loss of skin In favorable cases at least a part of a foot will be preserved for the patient to walk on Not only will the patient be spared the psychic trauma of losing an extremity but the preservation of the natural foot will preclude the increased strain on the other foot, which is certain to result from ambulation with crutches or an artificial leg It must be remembered that if the lesion is caused by arteriosclerosis, arteries in the sound leg may be involved to an equal degree and greatly increase the hazards of trifling injuries to the remaining foot For this reason amputation of the first foot should be avoided as long as possible in the arteriosclerotic patient. Bilaterally deficient circulation renders ambulation with an artificial limb a much more hazardous undertaking than it would be in a younger individual whose foot might be amputated for a crush injury and whose remaining foot had normal arterial circulation

## PREVENTION OF FOOT COMPLICATIONS

Most foot lesions are preventable and have their origin in minor injuries which could

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FIG 1 Gangrene from hot water bottle.

have been forestalled if the patient had been aware of the hazards and had used care to avoid them

Good diabetic control is an important preventive measure Patients should be warned that poor control favors infection, disturbed lipoprotein metabolism atherosclerosis and neuritis

With the onset of claudication, leg cramps and cold feet, the patient should be made aware of the impaired circulation, and proper foot hygiene should be re-emphasized Patients are frequently unaware of impaired pain and temperature sensation, and thus are deprived of this important protection against various forms of trauma, heat, cold and chemical agents Loss of pain sense may allow a noxious agent to remain in contact long enough to produce necrosis of tissue It is for this reason that hot water bottles and self-surgery should be forbidden.

Diabetics should be told to take care to keep the skin of their feet intact. This is particularly true where the skin has become thin, inelastic and deprived of its fatty subcutaneous cushion, as a result of impaired circulation A daily foot bath is recommended avoiding excessive use of soap and thereby preserving natural oil. Dryness and cracking can be avoided by oiling the skin with lanolin, baby oil containing lanolin or petrolatum

Patients should be warned of the dangers in the use of all forms of heat, ordinary skin antiseptics, home remedies and salves. The combined analgesic and necrosing properties of phenol render its use even when diluted, especially hazardous and its use without medical supervision has resulted directly in loss of an extremity Tincture of iodine is too harmful to tissues for use in the diabetic foot. Alcohol (70%) has been satisfactory for use as an antiseptic in the home and our patients are advised to use nothing else without the permission of the doctor

Hot water bottles chemical heat bottles and electric pads are not to be used because of the burn hazard if pain and temperature sense is impaired.

It is our feeling that all foot care beyond the ordinary daily hygiene should be in the hands of a trained person The diabetic person should not do any cutting or peeling of skin Patients are encouraged to report at once to their doctor if anything unusual about their feet occurs The use of adhesive tape has resulted in skin injury when the skin is thin and atrophic The superficial layer of skin can easily be pulled away with the tape as it is removed, resulting in an ulcer If adhesive tape is to be used, it should be applied to the outside of the dressing, or only to healthy skin.

Socks should be of ample size both as to the length and width, to avoid binding the toes together Socks preferably should provide a slight cushioning effect against the sole and the upper part of the shoe and allow air circulation

Shoes should provide a full half inch space beyond the great toe and be wide enough to allow all toes to be moved. A last should be selected which allows the first toe to be in line with its metatarsal without pressure of the shoe corner on the nail of the great toe The lining should be smooth free from pro-





Fig 2. Cellulitis from infected callus.

jecting seams and hard ridges It is better to have no lining than one that is torn The inside of the shoe should be examined frequently with the hands to detect foreign bodies and nail points which can injure the neuritic foot repeatedly without the patient's becoming aware of it. Soft leather has the advantage of not traumatizing the skin but has the disadvantage of exposing the toes to injury by falling objects Hard metal toes (with ample room) are needed where metal and heavy objects are handled New shoes, even if they fulfill the above requirements never should be worn more than an hour or two for the first few days. After shoes have been broken in daily pressure on the same area can be avoided by wearing different shoes on alternate days The patient should not walk without the protection of shoes or slippers

The nails should be trimmed straight across the corner thus produced may be rounded slightly but should be outside the skin fold If the shoes are ample in size nothing further is needed to prevent ingrown nails Nail trimming should not be done by the patient, because he must cut from an awkward position he may cut too deeply because of neuritis or impaired vision.

Corns usually result from ill-fitting shoes They can be prevented or relieved by proper fitting shoes Corns never should be trimmed by the patient or other untrained person First, the pressure should be relieved by allowing sufficient room in the shoe The corn may be softened by alternate soaks in water-and-oil applications With the pressure relieved, the softened corn will be extruded gradually The top of the corn may be cut off gradually as it lifts itself out. This is performed best by a physician, a nurse who understands the problem or a co-operative chiropodist.

Callus is also a result of continuous pressure usually to a larger area than with a corn and usually on the sole of the foot. When callus results from disturbed foot mechanics, the orthopaedic surgeon may help Excessive pressure on the callus may be relieved by using a sponge-rubber ring in the shoe [1] Calluses can be removed by relieving the heavy pressure and by advising patient to



FIG 3 B K. Infection and necrosis from stepping on a cement block

oil with lanolin baby oil or petrolatum. After softening, the callus can be pared down gradually if necessary The callus with its ischemic underlying tissue is a frequent site of chronic infection and deep ulcer Healing of the ulcer cannot be accomplished until the surrounding rim of callus has been pared down This operation can be facilitated by rest in bed and softening of the callus by soaking. This type of plantar ulcer is a constant invitation to organisms capable of producing cellulitis of the foot.

Another point of entrance for microorganisms is the fissure between the toes This may result from a fungus infection or simply from excessive moisture Shoes which are wide enough to allow air circulation between the toes will reduce perspiration and the susceptibility to fungus infection. The skin between the toes should be dried thoroughly Propionic acid dusting powder (Desenex) daily will combat moisture and act as a safe fungicide Strong fungicides should be avoided.

## EVALUATION

In arriving at a program, the cause of the lesion and also the previous treatment are of considerable importance Obviously gangrene that develops without injury and under hygienic conditions presupposes a degree of circulatory impairment greater than in a case where there has been exposure to heat, cold, mechanical trauma, chemical bacterial agents and would lead to a graver prognosis. When an ulcer has been overtreated with irritating antiseptics subjected to the continued stress of poor footwear or poor foot hygiene, often a rapid improvement will ensue when the patient is put at rest and irritating agents are removed. Obviously a foot ulcer will not heal when the patient continues to walk on an exposed shoe nail, which produces no pain because of neuritis A prognosis should be withheld until the natural reparative processes have had a chance to respond to more hygienic conditions and infection has been controlled by antibiotics.

The circulation to an extremity can be assessed by clinical examination Special tests are usually not necessary Calcified vessels in the leg and the foot as shown by roentgenograms may still transport blood, even in the absence of arterial pulsation A gangrenous toe means that no blood is reaching the toe However if the skin of the foot is warm elastic of normal thickness with some

subcutaneous fat and if pulsations can be felt in the dorsalis pedis and the posterior tibial arteries, it can be assumed that the body of the foot has a supply of blood and healing could be expected without loss of the foot

If the skin of the foot is thin tightly applied to the tendons with absence of subcutaneous fatty tissue, colder than the other foot, and arterial pulsations are absent it can be assumed that there has been gradual arterial occlusion above the ankle If there is atrophy of the calf muscles and intermittent



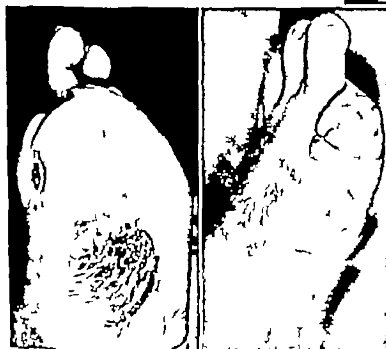


FIG 4 F B Osteomyelitis following surgical amputation

claudication the level of the occlusion is in the thigh Where there is occlusion of arteries above the ankle the refilling of the veins in the foot will be delayed after they have been emptied by pressure Added evidence of decreased blood flow is the pallor which develops when the foot is elevated. The dependent foot will show redness and cyanosis due to vasodilatation and stasis.

If the impairment of circulation is sufficient to produce tissue atrophy surgical procedures such as transmetatarsal amputations may lead to necrosis If gangrene is confined to a toe or toes, it is advisable to allow the toe to separate itself from the foot

Sudden arterial occlusion in which there has not been enough time for collateral circulation may lead to massive gangrene requiring amputation above the occlusion level In some cases, the occlusion may be confined to a short segment of the artery and can be treated successfully by arterial transplant. While this field of surgery is making remarkable advances, the elderly diabetic almost always has a generalized process not suitable for such treatment.

## MANAGEMENT OF DIABETIC GANGRENE

Gangrene which continues to progress into the foot and produces local and systemic symptoms while under conservative supportive therapy usually will require amputation of the foot. Conservative management should be tried in cases where the gangrene is limited to a digit or digits.

The management of diabetic gangrene is indicated in the following outline

1 General health measures
2 Diabetic control
3 Protection against physical and chemical injury
4 Antibiotics
5 Vasodilators
6 Anticoagulants
7 Consideration of sympathectomy

The diabetic patient with gangrene of the foot should be put at rest. The diabetes is controlled meticulously This means that the



FIG 5 H M Amputation through metatarsals without surgery





fasting blood sugar should be between 100 and 150 milligrams per cent, and the 24 hour urine should contain no glucose or less than 15 to 20 Gm If the patient is anemic the condition should be corrected by trans fusion. The individual who is anemic and in negative nitrogen balance resists infection poorly and heals slowly If there is no azotemia, a good protein intake is given Testos terone may be of value in helping to put the patient in a positive nitrogen balance If there is neuropathy associated with the gan grene—and there usually is some—paren teral vitamin B and $B_{12}$ are given

The position of the patient and the limb in bed is important. It is a common practice to elevate the feet, particularly if there is edema This probably is of value in disease of the veins, but since this decreases the al ready short blood supply of the feet we see that a level position is maintained with the patient comfortable The foot is left exposed to the air and the leg is protected by a cradle which must be well padded so as to avoid further injury to the limb if the patient should happen to bump it. The foot and the leg are moved by the patient frequently to prevent the development of pressure areas where the foot rests on the bed Physiother apy is used to keep the joints mobile and to aid muscle tone in the rest of the leg and the body Heat is not applied, as it would in crease the metabolism of the cells thus re quiring more blood which is not available

If infection is present, antibiotics are started. By reducing the infection and the swelling there may be enough improvement of the blood supply to keep the gangrenous process to a minimum. Due to poor circula tion, large doses should be prescribed to ensure an effective concentration in the affected area. Before the day of antibiotics the in fection and the swelling would cut down the blood supply and the gangrene would advance rapidly up the foot and the leg.

Gangrene advances by thrombosis When the lesion seems to be progressive and there is considerable pain, a 10 to 14 day course of heparin is started The heparin seems to help control the pain as well as to prevent advancing of the gangrene Heparin is given intravenously 75 mg 5 times per day With this dosage there has been very little trouble with bleeding

Engelberg and Massell[3] have used heparin in peripheral vascular disease with some ben efit in walking tolerance Woldow *et al* [5] have shown that heparin had a lowering effect on lipemia in normal subjects and there was also a reduction of the gamma globulin con centration This suggests that a heparin globulin reaction may be related in the clear ing of lipemia

Drug therapy is somewhat limited in cases of gangrene of the foot Two types of medi cation are in use One type tends to increase the blood flow Among these are aminophylline Priscoline nicotinic acid and papaver ine. If some spasm is present, they may be of value The other type of drug used is one that controls pain. It is best to avoid nar cotics salicylates given at regular intervals with sedation control most of the pain Dry gangrene is usually painless. Alcohol by mouth may be tried for its sedative and vasodilating effect.

If there is a marked degree of vasospasm determined by the different tests a sympa thectomy should be considered Because the tests are not always conclusive preliminary paravertebral block may be tried. If the foot temperature is increased, a sympathectomy is indicated. The sympathectomy of course will not cause a reversal of the gangrenous process but rather keeps it from progressing and it does warm the leg and the foot so that they will be more comfortable

A case report shows the favorable out come where amputation was advised by some consultants B K. a 62 year-old female who had diabetes of 15 years duration, was ad mitted to Henry Ford Hospital in December 1951 for treatment of gangrene of the right foot. She had stepped on a concrete block 3 weeks before and 2 weeks later a large blister appeared on the plantar surface of

the foot. The blister broke and bloody pus was discharged.

Examination on admission showed an extensive gangrenous ulcer on the sole of the right foot. There was evidence of swelling and inflammation The admitting temperature was 103 , hemoglobin was 9 7 W.B C. 18,200 and blood sugar 154

The patient was placed on penicillin and was given blood. A surgical débridement was done. On the seventh hospital day, the foot was opened widely For 30 days saline soaks were used, alternating with streptodornase and streptokinase After 30 days the wound had cleared and healthy granulation tissue was present. Three months after admission the area was débrided, and a dermatome skin graft was done After 3½ months of hospitalization, the foot had healed, and the patient walked out of the hospital without crutches and with a usable foot.

## CONSERVATIVE SURGICAL PRINCIPLES

Injudicious mechanical instrumentation in the local care of open foot lesions may do a great deal of harm An active thrombosis may be precipitated in adjoining healthy tissue by attempts to separate dead tissue before the proper time The instinctive desire to do something extensive must be curbed, and only inspection and very gentle palpation with light pressure should be used during examinations The low vitality of the tissues always must be kept in mind. Tourniquets and clamps must be avoided, and the finest concepts of plastic surgery should be adhered to [2]

F B aged 64 had lost his right leg above the knee 3 years before admission. He was able to walk with an artificial limb but developed a callus on the left great toe which later ulcerated. The toe became gangrenous After 2 weeks the toe was dry and the gangrene was sharply demarcated. Although the toe was removed with a minimum of trauma to living tissue infection occurred in the tendons and the metatarsal bone and healing was delayed 6 months until the head of the first metatarsal was extruded spontaneously

If circulatory impairment is not sufficient to cause tissue atrophy in the foot, conservative foot amputations may be successful. Here as in repairs after trauma, as much viable tissue as possible should be conserved. Also as much of the metatarsals as possible should be saved as any additional length improves the walking ability

All pertinent phases of a patient's life and physical condition must be explored to determine the best method of treatment The financial position of a patient and his family his capacity for work, his ability to use a prosthesis the degree to which he will adhere to a medical program and advice and the condition of the opposite extremity are to be considered.

In our hands the results of a conservative attitude with the employment of all measures short of amputation have given very encouraging results Antibiotics by controlling infection have removed the urgency of amputation.

An unusually extensive self amputation is illustrated in the case of H M., aged 76 In a period of 10 years he had lost 7 toes, one after the other as a result of atherosclerosis and dry gangrene Gangrene involving the remaining 3 toes and extending into the metatarsal portion of the foot seemed to warrant removal of the leg above the knee (Fig. 5) *However the patient* was reluctant to undergo surgery and after a 2 year period the toes together with the heads of the metatarsal bones, became mummified and dropped off Following this soon the foot was completely healed.

Penicillin was administered during short febrile periods. No surgery was performed.

The principles of conservative therapy are given in the following outline

1 Adequate incisions for infection
2 Antibiotics
3 Trial of conservative management
4 Débridement
5 Local amputation
6 No tourniquet or tight dressing

## CONCLUSIONS

1 The conservative management of diabetic foot complications gives surprisingly good results Many patients respond to a conservative program where at an earlier date major amputations were considered to be necessary

2 The *avoidance of trauma of every type*, including injudicious probing and handling is of greatest importance if success is to be obtained.

3 A careful program of management is essential

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5 Woldow A. Chapman J E., and Evans, J M Fat tolerance in subjects with atherosclerosis heparin effects upon lipemia, lipoproteins and gamma globulin Am. Heart J 47.568 1954


## Le Pede Diabetic


*Summario in Interlingua*

In tanto que le expectate duration del vita de patientes diabetic deveni plus grande complicationes vascular del extremitates inferior se incontra plus frequentemente In *multe casos gangrena e infectiones es initiate* per inadequate pedicura o per negligentia resultante in trauma evitabile Un melior education del patiente poterea evitar le majoritate de iste complicationes

Lesiones que a prime vista pare esser sin spero monstra a vices un certe melioration post un o duo dies de reposo Si le infection es subjugate per medio de antibioticos, le tractamento conservative pote esser continuate sin risco e resultatos favorable pote esser *attingite sin intervention chirurgic*

Un extension del processo gangrenose e non presentia de signos de curation es incontrate frequentemente si un amputation es riscate in un pede con forte reduction del fluxo de sanguine In iste situation gangrenose digitos del pede pote curar se post auto-amputation Un amputation chirurgic deberea effectuar se in tal casos supra le genu pro assecurar un adequate apporto de sanguine pro le processo curative Le perdita *de un pede e le resultante ambulation* per medio de un prosthese augmenta le effortios del remanente pede que usualmente suffre de un simile grado de impedimento circulatori. Assi le resultato final pote esser le perdita de ambe extremitates inferior Le plus grande importantia debe esser attribuite al evitar de omne genere de trauma, includente omne injudiciose probatura e manipulation

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In tanto que le expectate duration del vita de patientes diabetic deveni plus grande complicationes vascular del extremitates infe rior se incontra plus frequentemente In multe casos gangrena e infectiones es initiate per inadequate pedicura o per negligentia resultante in trauma evitabile Un melior education del patiente poterea evitar le ma joritate de iste complicationes

Lesiones que a prime vista pare esser sin spero monstra a vices un certe melioration post un o duo dies de reposo Si le infection es subjugate per medio de antibioticos le tractamento conservative pote esser continu ate sin risco e resultatos favorable pote esser attingite sin intervention chirurgic

Un extension del processo gangrenose e non presentia de signos de curation es incon trate frequentemente si un amputation es riscate in un pede con forte reduction del fluxo de sanguine In iste situation gan grenose digitos del pede pote curar se post auto-amputation Un amputation chirurgic deberea effectuar se in tal casos supra le genu pro assecurar un adequate apporto de sanguine pro le processo curative Le perdita de un pede e le resultante ambulation per medio de un prosthese augmenta le effortios del remanente pede que usualmente suffre de un simile grado de impedimento circula tori Assi le resultato final pote esser le perdita de ambe extremitates inferior Le plus grande importantia debe esser attribuite al evitar de omne genere de trauma, inclu dente omne injudiciose probatura e manipu lation.

# 22

# External Pin Fixation Used in Fractures of the Mandible*

Hugh D Burke, D D S

In considering the treatment of fractures of the mandible we find that they require a specialized treatment, which is directed toward the establishment of a normal function of the jaws and the teeth and the prevention of infection and facial disfigurement.

The classification and the zoning of fractures of the mandible is important, and we have set up the following outline for mandibular fractures

1 Fractures occurring within the dentition, that is, those found in the areas occupied by the teeth

2 Fractures posterior to the dentition namely those found in the angle of the ramus

3 Fractures of the neck of the condyle

4 Fractures of the head of the condyle

5 Fractures of the coronoid process

6 Fractures occurring in the edentulous mouth. They may be found in the symphysis, in the area of the mental foramen in the angle in the ascending ramus in the condyle and in the coronoid process

The mechanical factors to be accomplished are

1 Reduction of the fracture

2 Fixation of the fragments

3 Normal restoration of the occlusion of the teeth

Nothing is so conducive to early fracture healing as the positive maintenance of alignment and accurate apposition of the fragments The constant maintenance of com

* Presented at a meeting of the American Fracture Association Houston, Texas, Oct., 1954

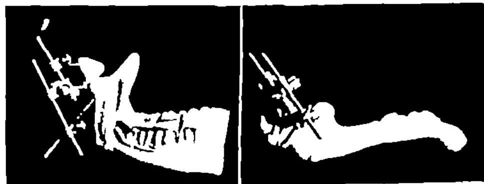
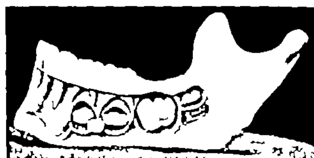


Fig. 1 (*Left*) Shows position of pins in upper fragment of condyle fracture (*Right*) Distal portion of mandible showing position of pin in lower fragment. Two pins are placed in the upper fragment and a single pin in the lower fragment, provided that the pin is embedded in good hard cortical bone





Fig 3 (Case 1) (*Left top*) Boy 5½ years of age was struck by a car The symphysis of the mandible was fractured, and there was extensive intra-oral trauma The right humerus also was fractured Exterior view of both fractures (*Left bottom*) Lateral view of deciduous mandible showing position of tooth germs Pins must be inserted below tooth germ sac (*Right top*) Three weeks after operation (*Right bottom*) Nine weeks after operation showing good formation of bone structure





coming the muscular action and establishing a normal occlusion and natural jaw function If we by pass this important thought of normal occlusion and natural jaw function, we certainly have missed the boat," because if a fractured mandible is reduced in a faulty position the deformity produced and the subsequent impaired function are so irksome to the patient that he will endure almost any ordeal necessary to have this correction made later on in life Therefore we must do the job well

This brings to mind the thought that we must see well what we are going to do and do well what we see Consequently we must have good roentgenograms in making a thorough examination of the mandible

Right and left laterals of the ascending ramus incorporating the head and the neck of the condyle and also the coronoid process should be taken An anteroposterior view should be taken to show the symphysis and the body of the mandible and an occlusal view should be taken to check the position of the teeth

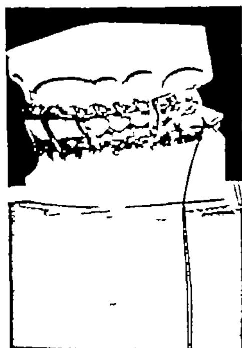
These are the 4 basic pictures that should be taken in the routine examination of the mandible Others may be taken if one deems it necessary

## PIN TOPOGRAPHY

In placing the pins in the tissue and into the bone itself strict asepsis is necessary and the extra-oral field must not be contaminated with the intra-oral contact. The patient is draped, and points for insertion of pins are selected, being careful not to place the pins too close to the line of fracture (at







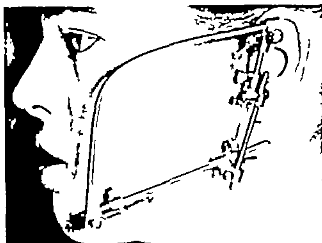


FIG. 4 (Case 2) (*Left top*) Girl 18 years of age, was in an automobile accident. The symphysis and the neck of the right condyle were fractured and there was medial displacement of the condyle head. This was reduced and fixed without open reduction. Preoperative roentgenogram.

(*Left center*) Model to aid in demonstrating the position and the approximate size of the rubber dam A long string of dental floss or suture material is attached to the roll and draped outside the patient s mouth to prevent his swallowing the roll of rubber dam.

(*Left bottom*) With the elastic traction in the anterior part of the mouth and the rubber dam in position in the posterior part of the mouth the lower fragment is depressed and the neck and the head of the condyle thereby are freed. Then, by engaging the pin in the upper fragment, the upper fragment is repositioned and reduced into its normal alignment, as shown here

(*Right top*) The intra-oral appliance now is removed from the maxilla, as shown It was decided to leave the intra oral appliance on the mandible because the alignment of the fractured symphysis was very satisfactory

(*Right bottom*) Close-up of external appliance with curved bar as designed by Dr David Murphy









FIG 5 (Case 3) (*Left top*) Tree trimmer 24 years of age, fell out of a tree and fractured the left angle of the mandible and the neck of the right condyle. Preoperative roentgenogram.

(*Left bottom*) Postoperative roentgenogram

(*Right top*) Lateral view of adult mandible the buccal plate having been removed. This illustrates the importance of keeping pins at the inferior border of the mandible. Pins were removed after 10 weeks and results were satisfactory

(*Right bottom*) Anterior view

least 6 mm away from it) Pins are put in at a 70 angle along the inferior border of the mandible incorporating as much of the *outer and the inner cortex as possible* We place 2 pins in each fragment. Pins are held together by a small bar and the bar of each fragment is held in place by a master bar Pins must be placed so that the soft tissue is left in normal position otherwise if the skin is distorted and under tension, we shall *have pressure necrosis of the soft tissue* causing severe drainage.

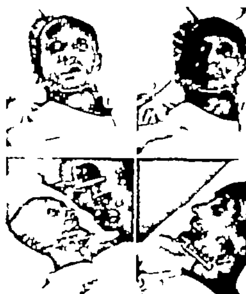
In fractures of the head and the neck of the condyle we are limited as to the appliance that can be used. The open reduction method is used and is reported as satisfactory It is described as follows

An angular vertical incision is made the *condyle is exposed* and a hole is drilled in the upper and the lower fragments Then a stainless steel wire is inserted, the fragments are put into position and the incision is closed The results as reported, are satisfactory However it has been our experience that these fractures that occur in the neck of the condyle can be reduced with external pin fixation without open reduction.

The condyle which is the articulating surface of the mandible measures from 15 to 20 mm long and about 8 to 10 mm. thick



FIG. 6 (Case 4) The patient a porter for the Pullman Company sustained a fracture of the jaw which evidently involved both mandibular rami when the train on which he was employed collided with another Reduction was effected by Roger Anderson mandibular apparatus This gave the patient mobility to eat and made him more comfortable. At time of discharge from the hospital the jaw was healed. The Roger Anderson pins and bars and the mandibular apparatus were removed.



(*Top right and two lower illustrations*—Burke, H D Murphy D L., and McNichols W A. A M.A. Arch. Surg. 51 279 282)

Its long axis is at right angles to the plane of the mandibular ramus In locating the head of the condyle bisect the tragus of the ear and make a stab puncture with the pin about 6 mm. anterior to the line bisecting the tragus of the ear The pin is carried inward until it has engaged the lateral pole of the condyle The pin should be carried into the head of the condyle about 18 mm. and it must be carried parallel with the long axis of the head of the condyle to ensure proper retention. If in doubt, the best way to check this is with roentgenograms It is always wise to measure the length of the condyle by means of x rays before making the initial puncture However after the pin has been inserted, it is well to follow up with an x ray picture to see whether or not the pin has penetrated the medial pole of the condyle If this has happened, the pin should be re-engaged with the chuck and backed out until the pin is flush with the cortex of the medial pole

A second pin is put in well down into the neck of the condyle in the upper fragment and the customary bar uniting the two pins is engaged. This gives us a handle to aid in reducing the upper fragment. Then 2 pins are placed in the lower fragment which would be the ascending ramus and, as we have said before we like to position these pins at an angle of about 70°

After both pins are put into position the customary bar is attached to these 2 pins and then the attempt for reduction is made.

However if there is too much muscle interference we resort to intra-oral traction, which may be described as using 2 wire splints that are bent to conform, one to the upper arch and one to the lower arch and they are wired to the individual teeth. On the labial surface of these bars is a small button like projection, and the teeth are brought into occlusion and held there by attaching elastic bands to the anterior part of the mouth

It must be remembered that we do not depend on the intra-oral method for fixation of the fragment. We merely use the intra-oral traction to overcome the trismatic condition that exists from the injury which has caused, in a majority of cases the overriding of the fragments We rely on the insertion of the pins for the reduction and on insertion of the bars for fixation

It is essential that we get the fragments in proper alignment before they are fixed.

Sometimes this takes several days because the tension needed to reduce the fracture and overcome the pressure of the injured muscles cannot be exerted at any one time

With the pins in position and with the tension within the mouth by the elastic bands we can jockey the fractured parts into normal apposition

Once this has been accomplished, the fragments are fixed by the external bars that are hooked on to the pins Consequently we are finished with the intra-oral traction.

The sooner we can dispose of the intra oral appliance the better off we are because with this appliance removed it is much easier to keep the mouth clean Also we can put the patient back on a normal diet which is very important.

In conclusion it might be said that the majority of fracture cases, regardless of the part of the body in which they occur will produce satisfactory results, if they are handled properly

### Questionnaire for Review of External Fixation of Fractured Mandible

(Results Anatomic Functional, Economic)

We are interested in your progress during the time your fracture was treated and also since your recovery Please answer the questions listed below

1 Did you have any discomfort round the pins or fracture site after the first week of wearing the appliance?

2 If you did have discomfort how soon after pinning did you notice it?

3 Were you able to open and close your mouth and masticate your food without any discomfort?

4 Were you able to brush your teeth and keep your mouth clean?

5 Did you have any drainage round the pins?

6 Did you have any drainage from the place where the pins were removed?

7 Is the jaw as comfortable and strong and as useful as before the injury?

## Fixation a Spinula Externe in Fracturas del Mandibula

*Summario in Interlingua*

In fixar fracturas del mandibula le spinulas debe esser placiate de maniera que le texito molle remane in position normal. Si tension o distortion del pelle resulta le position del spinulas responsabile debe esser cambiate Si un assistente placia su digitos intra le bucca del patiente Ille pote exercer un contra pression que es de grande adjuta in le insertion de spinulas in non fixe fragmentos.

Esseva usate le apparato mandibular de Roger Anderson in combination con le spinula mandibular de Leo Winter Le spinula de Winter esseva preferite a cousa del filettage special que es gravate in su puncta triangular Marcas de graduation in le trunco del spinula es de adjuta in estimar le penetration attingite

Le spinula es attachate a un forator manual Le prime punctura es lanceate in le texito molle a un angulo multo proxime al medio inter 60 e 75 grados

Le major objectivo es placiar le spinula al margine inferior del mandibula e incorporar le externe e le interne cortice sufficientemente pro obtenir un base secur pro le spinula durante le integre curso del processo curative

Omne fracturas mandibular pote esser reducite immediatemente Le functiones del mandibula e le occlusion del dentes es restaurate al norma. Le integre procedimento es clar e directe Illo es facile a surveliar E le patiente pote retornar a su activitates normal post un multo breve intervallo

# 23

# Carpometacarpal Dislocation

## A Case Report

ROBERT O WHITSON, M D *

The justification for reporting this single case of carpometacarpal dislocation is not an original method of treatment or exemplary results Because the result obtained in this case was not entirely satisfactory the literature was reviewed in order that the next case might be managed with a better knowledge of the principles involved In doing so it was found that carpometacarpal dislocations are rare and that recommendations for treatment are not precise This case is commented on in order to add another to the statistics and to attempt to draw some conclusions as to how such cases should be managed Isolated carpometacarpal dislocations and fracture dislocations of the thumb are fairly common These injuries are not the

* Baytown, Texas.

TABLE 1 CARPOMETACARPAL DISLOCATIONS (After Waugh and Yancey 1948)

| Type | | Number of Cases | Date First Report | Number of Reports |
|---|---|---|---|---|
| Isolated | V | 13 | 1879 | 10 |
| | II | 7 | 1853 | 7 |
| | III | 3 | 1844 | 3 |
| | IV | 3 | 1868 | 3 |
| Simultaneous | II V | 32 | 1856 | 30† |
| | IV V | 11 | 1865 | 8 |
| | II III | 10 | 1877 | 7 |
| | I V | 7 | 1873 | 7‡ |
| | II III IV | 3 | 1898 | 3 |
| | III IV | 3 | 1895 | 3 |
| | III, IV V | 1 | 1942 | 1 |

† Present report added

‡ Subsequent reports (Aulong 1951 Trojan 1952) added.

TABLE 2 INJURIES OF THE CARPUS

| | Injury | Cases |
|---|---|---|
| 1 | Recent fractures, carpal navicular | 154 |
| 2 | Old fractures, carpal navicular | 80 |
| 3 | Fractures of the lunate | 23 |
| 4 | Avulsion, posterior process, lunate | 59 |
| 5 | Recent closed dislocation lunate | 15 |
| 6. | Old closed dislocation lunate | 10 |
| 7 | Recent dislocation lunate with fracture navicular | 7 |
| 8 | Old dislocation lunate with old dislocation, navicular | 10 |
| 9 | Fracture triquetrum | 18 |
| 10 | Dislocation, triquetrum | 1 |
| 11 | Fracture pisiform | 13 |
| 12 | Dislocation, pisiform | 6 |
| 13 | Fracture trapezium | 13 |
| 14 | Fracture trapezoid | 1 |
| 15 | Fracture capitate | 6 |
| 16 | Dislocation, capitate | 1 |
| 17 | Fracture, body hamate | 8 |
| 18 | Fracture hook of hamate | 2 |
| 19 | Anterior dislocation, wrist | 3 |
| 20 | Posterior dislocation, wrist | 2 |
| 21 | Anterior dislocation, intercarpal joint | 1 |
| 22 | Posterior dislocation, intercarpal joint | 2 |
| 23 | Posterior dislocation, carpometacarpal joint | 2 |
| | | 437 |
| | Fractures or epiphyseal separations, lower radius during same period (Schnek, from Böhler 1935) | 669 |

subject of this report. This review is concerned primarily with posterior dislocation of the 4 medial metacarpals However when dislocation of the carpometacarpal joint of the thumb was associated with carpometacarpal dislocation of the 4 medial fingers,

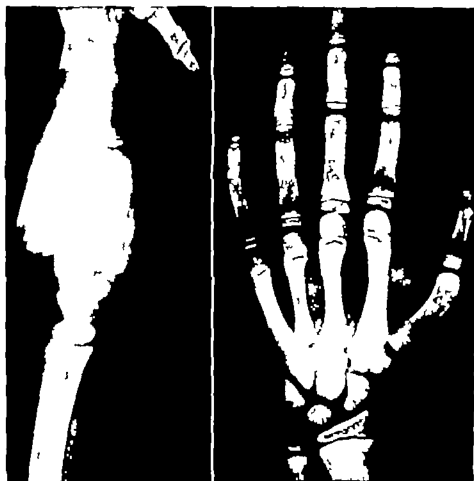


Fig 1 Roentgenograms on admission to hospital Posterior dislocation of the 4 medial metacarpals on the carpus.





Fig. 2. Reduction obtained by extension and flexion of the wrist.

the cases were included for study, for in every instance, it appeared that the dislocated carpometacarpal joints of the thumb and of the fingers presented 2 separate problems

The subject of carpometacarpal dislocations was reviewed by Waugh and Yancey[18] in 1948 with an extensive bibliography

The first table drawn from their report emphasizes the infrequency one meets with dislocations of the carpometacarpal joints other than the thumb Note that few authors were able to report more than a single case The second table by Schnek from Bohler[2] indicates the rarity of carpometacarpal dislocations in relation to other carpal injuries It is not surprising that the text books on fracture treatment devote only a few lines to carpometacarpal dislocations of the fingers

The present case is that of a 10-year-old boy who fell approximately 15 feet from a tree On the right he sustained a compound epiphyseal separation of the lower end of the radius. Approximately 1½ inches of the bone was exposed, and the epiphyseal plate was grossly contaminated On the left there was an obvious deformity due to shortening and thickening of the hand The bases of the 4 medial metacarpals could be palpated on the dorsum of the carpus. Roentgenograms (Fig. 1) confirmed the presence of a posterior dislocation of the 4 medial metacarpals. The patient was admitted to the hospital and under general anesthesia, surgery was performed Prior to starting on the right upper extremity the carpometacarpal dislocation on the left was manipulated A crepitation was felt, and this was interpreted as an indication that reduction of the dislocation had been obtained. Attention was then directed toward the débridement and reduction

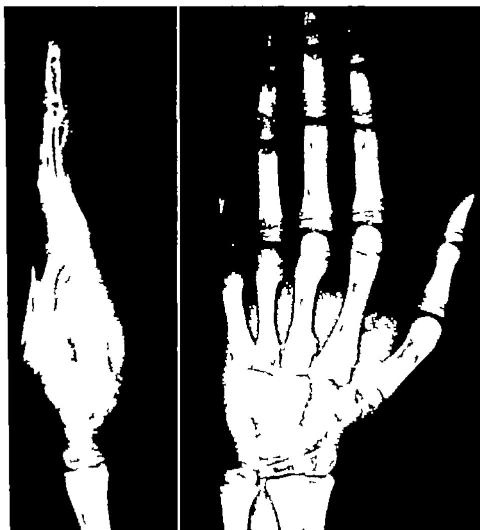


Fig 3 Final result after 4 weeks immobilization Note partial recurrence of the luxation

of the compound epiphyseal separation on the right, followed by closure of the wound and application of a long arm cast. The left forearm and wrist were then immobilized in "sugar-tong" plaster of Paris splints with the wrist in flexion. There was severe postoperative swelling bilaterally The wound at the right wrist drained slightly for 3 weeks and then closed. Postreduction films of the left wrist were interpreted as showing a partial recurrence of the dislocation. So one week following injury the left wrist was remanipulated. Portable films were taken at surgery with the wrist in extension and with the wrist in flexion, and it was found that the latter position resulted in a better reduction (Fig. 2) The forearm and the hand were immobilized in a posterior plaster of Paris splint in severe flexion. Subsequent roentgenograms (Fig. 3) revealed a partial recurrence of the luxation. Immobilization was discontinued at 4 weeks. The patient had visible deformity consisting of a ridge on the dorsum of the left hand. Function has improved steadily and is now quite satisfactory (Fig. 4 and 5) Further surgery was not desired for cosmetic improvement and was not indicated for functional improvement.

Reviewing case reports revealed that posterior dislocation of the medial 4 metacarpals occurs much more commonly than anterior Tillaux[16] reported an anterior dislocation which resulted from a fall on the flexed hand Stimson[15] reported a similar case Olper[10] in 1932 reported an anterior dislocation as the result of an automobile accident. Closed reduction in these cases apparently was not difficult, and after 2 to 3 weeks of immobilization, excellent function followed The other cases of anterior dislocation that could be found resulted from



Fig 4 Appearance of the hand at the conclusion of treatment.

direct trauma to the hand such as the hand s being run over by a wagon wheel or caught in the moving parts of machinery These cases were associated with a compounding wound. Suppuration was not uncommon and the functional results of these cases were not good

Table 3 summarizes the data obtained from the available case reports of posterior dislocation of the medial 4 metacarpals It should be noted that the trauma in each of these cases was severe Probably this de formity can occur as the result of one of two mechanisms In some cases, it appeared that the force was indirect namely a hyper flexion of the clenched hand Such disloca tions should reduce readily with traction and flexion and be stable with the wrist in hyper extension. It is probable that other disloca tions are produced by a direct force against the palm of the hand by an object which allows the wrist to move forward without restraint. Examples of this would be limbs of a tree a steering wheel or handle bars, that were grasped in an effort to arrest the subject s momentum One might expect such dislocations to be more difficult to reduce and frequently to be unstable Referring again to the table it is noted that frequently more than one manipulation was required, and that recurrence of subluxation was not uncommon Good function is customarily reported even when there is no reduction

The following conclusions have been drawn from this review

1 Closed manipulation should be per formed as early as possible because of the severe swelling that will follow

2 Reduction usually can be obtained by traction in the flexed position If the wrist is brought into extension with pressure over the bases of the metacarpals the reduction will be stable if the dislocation has been produced by indirect violence

3 If the reduction is unstable open operation and maintenance of reduction by transfixing wires usually is indicated

4 Even though good reduction is not obtained, function is likely to be good or excellent.

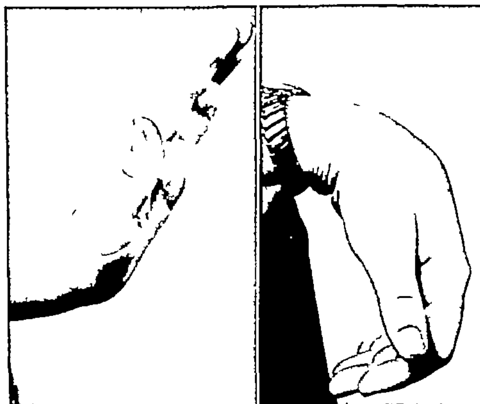


Fig 5 Range of motion at conclusion of treatment.

Table 3 Posterior Dislocation of Metacarpus on Carpus

| Author | Injury | Treatment | Result |
|---|---|---|---|
| Poulain 1912 | Fall of 10-12 feet | None. | Mild limitation motion |
| McLean 1922 | Struck by pole when chain broke. | Reduction closed, 1 week after injury | Index metacarpal incompletely reduced. Good function |
| Carter 1924 | Fell 25 feet | Closed manipulation Pad to counteract tendency to recur | Function satisfactory |
| Malartic 1925 | Bicycle crash into a wall. | 2 closed manipulations<br>Open reduction | No reduction<br>Excellent |
| Metz, 1926 | Fell through hold of a ship | 2 closed manipulations<br>Open reduction | No reduction<br>Excellent |
| Burmeister 1931 | Car turned over | None | Gross deformity good function |
| Petronio 1936 | Motorcycle accident | Early and late closed manipulation<br>Open reduction with excision bases 4 medial metacarpals. | No reduction<br>Good function mild limitation motion |
| Shorbe 1938 | Fell down stairway | Closed reduction<br>Traction and compression pad | Partial recurrence<br>Good function |
| Estrade 1939 | Bicycle truck accident. | Closed reduction | Good position good function |
| Key and Conwell, 1942 | Not given | Closed manipulation.<br>Open reduction | No reduction<br>Good function |
| Aulong, 1951 | Motorcycle accident | Closed reduction<br>Remanipulation strong hyperextension | Recurrence.<br>Reduction maintained good function |
| Trojan 1952 | Explosion (compounded) | Débridement, manipulation | Good. |

It is hoped that this report will be of some use to others as the author is statistically unlikely to encounter another such case *

Acknowledgement is due the Library of the American College of Surgeons for translations of case reports appearing in the foreign literature

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## Dislocation Carpo Metacarpal Reporto de un Caso

*Summario in Interlingua*


Dislocation posterior del quatro metacarpales al carpo es de occurrentia rar Le presente reporto adde un caso al litteratura Un puero de 10 annos cadeva ab un arbore ex un altitude de circa 5 m Ille suffreva un aperte separation epiphysee del termino distal del radio a un latere e un dislocation posterior del ossos metacarpal 2 a 5 al altere latere Le prime reduction del dislocation carpometacarpal esseva considerate como inadequate Pelliculas portabile monstrava post remanipulation un melior reduction in flexion que in extension Assi le carpo esseva immobilisate in flexion Tamen, il occurreva un recurrentia partial del dislocation. Post le completion del tractamento il remaneva un deformitate visibile Nonobstante le functionamento esseva bon

Esseva facite un revista del litteratura pro definir principios de tractamento in possibile casos futur Proque iste lesion es si rar le conclusiones del studio es hic publicate (1) Le manipulation clause deberea esser executate le plus promptemente possibile a causa del sever intumescentia que seque in omne casos. (2) Reduction es generalmente possibile per traction in position flectite Si postea le carpo es ponite in extension per pression super le bases metacarpal, le reduction que resulta es stabile si le dislocation esseva le effecto de violentia indirecte (3) Si le reduction es instabile un operation aperte e mantenentia del reduction per medio de transfixion a filos de metallo es usualmente indicate (4) Mesmo si le reduction obtenite non es bon, il es probabile que le functiones restablite es bon o excellente

Section III

"ITEMS

# Section III

## "ITEMS"

# 24

# The Spectatoı

JOHN CHARNLEY, F R C S *

DEAR SPECTATORS

I have very much enjoyed receiving your letters and as much as any I have enjoyed the little personal comments and human touches scattered among the very useful scientific facts These letters seem the ideal way of trying to express those private opin ions which one might never dare to try out in public.

For my letter I would like to try to develop some half-conceived ideas concerning the aches and pains of orthopaedic patients and the rough and ready psychiatry which we surgeons slowly teach ourselves to prac tice Whether by the end of this letter I shall get anywhere in crystallizing these rumina tions, I know at the moment no more than you!

I have just had or for that matter still have a "tennis elbow" and about 18 months ago I now remember having had a supra spinatus syndrome and though distinctly an noying I have found neither of these conditions sufficiently disturbing to make me bother to have "treatment." I find myself wondering whether I must have a higher threshold for pain than most of my patients or whether I have had both these conditions in a milder degree than do the dozens of pa tients one can see any day of the week in a large city clinic. What a wonderful thing it would be if we could measure pain quanti tatively by the number and intensity of the pain impulses ascending the sensory nerves and before these impulses impinge on the sensory cortex! Perhaps some day this will be possible

We all know that thousands of patients sustain attacks of "lumbago and "fibrositis" without calling in their medical practi tioners but I think that from our earliest student days we have taken it as self-evident that those sufferers who come to specialists must therefore have "lumbago" and "fibrositis" of a more serious degree than those who stay away In a small percentage we can elicit objective physical signs but the vast majority reveal only the subjective sign of tenderness more or less localized but have we any proof that the sensory nerves of these patients are carrying a scrap more pain than what, in an ordinary phlegmatic indi vidual would hardly be noticed?

There is of course the group of patients who come with a mild pain on the superficially plausible grounds that they know patients who were told that had they come to the doctor earlier their condition would have been treated easily How many of these patients really are satisfied if they are merely reassured by being examined and told that there is nothing wrong? Basically they are all much happier if in addition to being told there is nothing wrong they are also given some 'treatment" This is where all free Health Schemes collapse it is quite wrong to

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expect one citizen to contribute to the treatment of another if that treatment is merely *'a little bit of what you fancy" and is not* dictated by scientific medical necessity

As one who has a detached interest in human behavior and mannerisms, I think that most patients can be classified into two groups (1) the seriously injured and diseased (excluding compensation cases) and (2) the lumbago-sciatica fibrositis group (without objective signs) I believe that there is a detectable difference in the massed personalities of, say, a hundred patients under inpatient treatment for serious accidents or diseases and a hundred outpatients of the fibrositis-backache group The former contains a high proportion of patients with some quality in their personality which makes one warm toward them as simple ordinary people seriously afflicted by a catastrophe The latter do not. One saw this in its most clear *cut form in military hospitals during the* war in our British hospitals I always felt that the wounded were exactly the same sort and type of men that I was meeting in the ordinary course of life but in the outpatient department the lumbagos and the sciaticas contained a much higher proportion of the type of men whom one had no particular desire to see again or to know what happened to them

One may argue of course that this is merely subjective and mere prejudice that it indicates the biased observer whose recollections conveniently fit his theories But I do not think so because The injured and diseased are of necessity an unselected cross-section of one's fellow men, whereas the lumbago-fibrositis group is a selected group That is to say accidents and disease strike the phlegmatic and the neurotic elements of the human race equally and without discrimination and therefore the patients coming to hospital reveal a proportion of "normal" individuals to "neurotic" reflecting the proportion in the general population Lumbago fibrositis tennis-elbow etc also will strike all categories of the human race in discriminately but, on the other hand, patients who present themselves at hosp *will contain a much higher* proportion neurotics because the decision to go to h pital is initiated by the patient himself is not dictated by the external fact that h pital treatment is inescapable

Let us now see what the effect will be applying the same clinical assessment to "selected fibrositis group that we unc sciously apply to the "unselected disea group From ordinary experience with unselected disease group let us suppose t we have become accustomed to expect ab 10 per cent of patients to have a detecta neurosis superimposed on their disease subconsciously we apply the same prop *tion to the fibrositis group we now do it* contrasting the 10 per cent who are fran cally hysterical against the remaining 90 p cent who by comparison, seem to be n *mal I suggest that seen against a differe* background, even this 90 per cent wou then be revealed as being distinctly abn mal in their threshold for pain

Those who enjoy an argument may n retaliate that it is all very well to divide p tients into two groups—the unselected, ra dom cross-section of humanity and t self-selected neurotics—but why not divi surgeons also into two groups (1) t kindly decent thinking, slightly sentiment humanitarians typical of a random cros section of the human race and (2) the co carping critics the cynics and the unsucces ful clinicians from whom patients immed ately go to another consultant this is t self-selected group comprising the mela cholics and the sadists!

I am now getting even less sure than eve where my rambling argument is leading!

Would it perhaps be true to say that sc entific truth is more likely to be appreciate in the self selected cynical group than in th genial unselected group? Might it be tru (this is a horrible thing to suggest) that th nearer a doctor is to the ignorant, supersti tious and unscientific layman the mor

prosperous would be his practice? Might not a hysterical doctor having himself a low threshold for pain be more sympathetic and considerate toward his patients than one who might have been brought up from childhood to admire the ways of life in ancient Sparta? A "good doctor" must believe implicitly in what he recommends to his patients but only an ignoramus can really *believe* that heat, short wave diathermy or massage can cure "rheumatism"

From the point of view of a surgeon's scientific education I think the practical significance of these rambling thoughts is the vital importance of orthopaedic surgeons retaining a comprehensive practice of "general" orthopaedics without exclusive specialization Specialize certainly but never at the expense of losing contact with access to the whole unselected cross-section of human psychology The opinion of a "100 per cent backache surgeon" (if such an awful thing were to exist) would be utterly valueless in a discussion on fractures of the spine if that "backache surgeon" were not continuously in contact with the mass personality of unselected disease and injury A surgeon doomed all his life only to see patients with backache would soon lose the ability to recognize the personality of a "normal" man if ever were to see one The average psychiatrist often regards as cured a patient whom we would think as obviously "nuts." England many of us believe that time is beginning to show that the best disk surgery being done by orthopaedists rather than neurosurgeons (how nice it is to know that I am writing a private letter to fellow orthopaedists!) The training of the neurosurgeon at least in England tends toward that of the neurologist and the unpractical physician rather than to that of the more robust, man-to-man approach of the good general surgeon or orthopaedist Unlike the orthopaedist, many neurosurgeons here do not easily recognize minor grades of neurosis because they so rarely deal with patients who are unquestionably "normal."

So you see I don't, on the whole think much of the average patient with backache Even an apparently successful result usually has something to spoil the perfection they are now often worried by a patch of cutaneous anesthesia if an autogenous iliac graft has been used. There is something significant in the lack of a sense of humor which I always think is so very characteristic of the neurotic the average "normal" man may curse his backache but he generally laughs at it. To the normal mentality the word lumbago suggests a music hall joke—but never a smile does it squeeze from the neurotic

Well my dear fellow Spectators I find I have not achieved the inspired thoughts which at the beginning I felt might be somewhere just round the corner—however it has done nobody any harm, it has amused me in a vague sort of way and your wastepaper basket is near at hand.

Goodbye for now

Yours very sincerely
John Charnley

# 25

# Orthopaedics and the African

J H G ROBERTSON, M CH (ORTH), F R C S, ED *

DEAR SPECTATORS

My wife who is touring in the United States wrote me the other day that out of several hundreds of people whom she had met and talked to only two owned to having heard of Southern Rhodesia or knew where it was She was asked whether it was in Spain, or a part of Ceylon, and whether the capital was not Timbuctoo So perhaps it might be as well to start by saying that my country is a self-governing colony—one of those British contradictions in terms!—about 3½ times the size of the British Isles and situated right in the middle of south Central Africa with the Zambesi River on our northern boundary and to the south the other side of the Limpopo river The Union of South Africa. Please note that we are emphatically not a part of the Union of South Africa nothing upsets Rhodesians more than this very common misconception.

In 1890 this part of the world was a blank on the map—an unknown and malaria ridden land into which a few missionaries and ivory hunters had made adventurous journeys Because of stories of gold that these hunters brought back Cecil John Rhodes wrung a concession from Lobengula, the king of the warlike Matabele tribe who had subjugated the surrounding peoples and sent up a column to occupy the country They set up their flag in the center of what is now the city of Salisbury about a mile from where I am sitting writing this letter only 63 years ago A small handful of that original band of pioneers survives. What changes they have seen!

But it is primarily of the Africans that I wish to write We do not know their numbers at the time of the European occupation and we do not know their numbers now as a census is not yet a practical proposition, but there is no doubt at all that with modern sanitation malaria control, famine relief vaccination for smallpox and so on their numbers are increasing rapidly—some say doubling every 25 years They outnumber the European population by roughly 20 to 1

In the early days common humanity demanded that the Europeans make medical treatment available to the Africans No people anywhere could have stood in greater need of what Western medicine had to offer; the amount of work to be done was enormous but, of course, the African could not possibly pay for it himself So it came about that the Government, which means the European taxpayer provided it free—doctors, nurses, hospitals everything. That was the beginning of the Southern Rhodesian Medical Service to which I belong For many years the African maintained an attitude of suspicion and mistrust of the white man's ways so that the Service remained a small one I joined it 20 years ago just before it entered a phase of rapid expansion and development. A Government Medical Officer

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then had to be a Jack-of all trades I used to deal with smallpox epidemics and malaria prevention act as foreman of works when new hospital huts were built and operate on anything that came along. A lot of the operative work was complicated midwifery—the idea that the African woman gives birth to her child easily and painlessly is a myth Cataracts, too I taught myself to do Although for a long time now I have not strayed from the paths of orthopaedics I still think that there is no other satisfaction in surgery to compare with that of restoring vision to someone who has been blind for years Life does not hold much for a blind African. Incidentally, my colleagues here are now inserting an acrylic lens when they do cataracts Africans particularly elderly ones, lose or befoul their spectacles so easily and the inert implanted lens seems to be exactly the right answer

Well, we moved with the times special ization came, and I was transfered to larger hospitals and concentrated on orthopaedic work. For 10 years I was in Bulawayo down in the South on the fringe of the desert That is the address that most of you have—the Memorial Hospital In April of this year I came up to Salisbury the capital to be in charge of the group of hospitals here I still do not know that I have done the right thing. Administrative work tends to intrude on the time that I would wish to set aside for clinics, ward rounds and operating

Now to give you some idea of the special problems of orthopaedic work here First and most important is the extraordinary difficulty of keeping records of your cases The African cheerfully subscribes to the phrase "What s in a name?" He changes his quite readily—that is his European adopted name—Charlie Jim Fish Cigarette or whatever it may be and although he always retains his tribal or vernacular name that is usually not reducible to English spelling, and it always begins with an "M" anyway which makes filing awkward He has no address, there is no rural postal delivery so you cannot get him to come up for a regular checkup We are beginning of course to get a settled population of African middle class in the two cities but that is a recent thing and the bulk of our work is still with the more primitive folk So I can't give you statistics Although most of my work has been with Africans our service setup leaves me free to undertake consulting work—which is all European and in addition I see European schoolchildren police, army trainees Air Force personnel and so on as part of my official duties—so that I am in a good position to appreciate the differences between the races as they occur in practice Some of these I hope to be able to tell you about

Some time ago some Spectator reviewed a number of conditions starting with the feet and working upward. That has the merit of simplicity anyway and I shall do it that way too

Before I start though—a word about keloid formation The African is of course peculiarly liable to it and it enters into one s consideration when any form of surgery is contemplated. So much is this the case that many tribes pattern themselves in the most elaborate way with a mass of keloid scars which they induce by rubbing powdered root into superficial skin incisions

I do not find the recommended practice of irradiating the skin with x rays both before and after surgery is as successful as the books make it out to be Several other surgeons agree with me that there seem to be times when the individual will form keloid and times when he will not. What basis this may have in hormonal fluctuations I do not know but I believe it to be the case A practical point of interest is that in many cases you can spot the wound that is going to develop keloid overgrowth before the stitches are taken out—the patient complains of a peculiar pain in it, which is not due to sepsis. Often it is described as a "tight feeling"

Foot troubles—with one exception dealt

a couple of tennis balls This condition always is due to syphilis but is one that I do not remember having seen mentioned in the literature

We see a lot of osteomyelitis always of the staphylococcal type with insidious onset. The fulminating streptococcal type present in an acutely ill child simply does not occur in the African yet we see it in the European The antibiotics of course do not touch the chronic staphylococcal variety and we go in for somewhat heroic diaphysectomies—and often get a sound and useful limb

Tuberculosis is our No 1 problem both from the medical and the surgical angles When I started practice here there was no problem the African got his tuberculosis as a "galloping consumption" and died of a miliary spread in a matter of weeks or months. Today his resistance has developed to a point where all the chronic pulmonary and bone lesions are found, and we cannot begin to provide adequate treatment for all the sufferers There is no essential difference between the bone and joint tuberculosis of the European and the African except that resistance tends to be less in the latter Also we often see the cases in a late stage a condition that never would have been allowed to develop in the European before seeking advice In some ways this is not as bad a thing as it sounds. I am being heretical here but I am impressed with the number of tubercular joints that I see that have attained arrest of the disease and bony ankylosis without treatment of any kind. They are all distorted, of course the hips are flexed to a right angle and adducted, the knees similarly flexed. The sufferers simply lay on their backs and assumed the position of least discomfort, which was presumably where the opposing muscle spasm canceled out The number of these joints that fused without treatment was I am sure, better than that attained when one got the case during the invasion stage and used traction and immobilization in a plaster cast in the orthodox position. There is a lesson to be learned here I feel Wilkinson, of the Black Notley Sanatorium in England, if I understand him aright, advocated an intertrochanteric osteotomy in the tubercular hip so as to allow the head and the neck to take up a position most conducive to healing, while allowing the leg to be brought down into the position of function I have not exactly gone in for neglect as a deliberate policy but some of my patients on whom I have done a late osteotomy have given me better results than cases treated more orthodoxly from the beginning I like a quiescent T B knee with firm fibrous ankylosis in right angled flexion. The operation to get bony union in extension is easy and there is no need to put Steinmann pins through the bones to get firm apposition—the contracted hamstrings do the job beautifully holding the trimmed bone ends together firmly

About backs I am interested in low backache and see a lot of it in Europeans I have a disk syndrome myself, which sharpens the interest. Our European population are the worst disk syndrome sufferers anywhere, I should think The number of Africans that I have seen with the full-blown syndrome I can count on the fingers of one hand—and some of those cases were doubtful. Yet it is the African who does the heavy manual labor and on roentgenograms you find all the anomalies and the abnormalities of the lumbosacral region that you do in the European Why should there be the discrepancy? I can only suggest some points that may be significant. First, the African has, racially a more pronounced lumbar lordosis than the European Second, he is a great walker and consequently his lower back muscles are well developed Third, he does not go about in motor cars! Rhodesia is in the proud position of world leader when it comes to the ratio of motor cars per head of European population—there are about twice as many as in the

States they tell me I don t think the high incidence of the disk syndrome can be dissociated from the use of motor cars

It seems to me that as one bumps along mile after mile particularly in the driving position, with the lumbar lordosis undone one must be submitting the posterior part of the annulus and the posterior common ligament to continuous insult injury and strain No wonder laxity and protrusion develop

I suppose that writing from Central Africa some reference to witchcraft is expected of one We have plenty of it However civilized he may appear on the surface every African will revert, when things go wrong to the beliefs and the practices of his ancestors

Most of these are crude and hardly worthy of serious attention but not quite all are so In the rainy hills of our eastern border there is a curious custom—the use of professional thieves. You do not steal a thing yourself to do so would be dishonest but there is nothing against employing a professional thief to steal it for you at a prearranged fee These professional thieves—"goros" they are called—use a powdered root which they scatter on the embers of a fire when their intended victims are crouched round warming themselves The active principle of the root, whatever it may be is given off in the smoke that results The effect it produces is to bring about a sort of paralysis of the will to action without in any way affecting consciousness. A friend of mine who had it done to him told me that he watched in a detached sort of way while the thieves took his rifle and his clothing and made away with them He knew what was happening, and knew that he ought to do something to stop it, but as he put it he "just didn t care about it at all It didn t seem worth bothering about."

The native name of the root is known but the identity of the plant I never have been able to discover The thing that strikes me is that it might provide a wonderful preoperative medication if one could get hold of enough of it to experiment on and obtain a purified extract I shall go on trying

I have rather enjoyed getting some of my theories off my chest Most of you refer to congresses and conferences which you attend as a matter of course in this part of the world distances are vast and people of like interests too far apart to make anything of that sort possible So this postal contact means a lot to someone like myself it helps to keep one on tiptoe I should like to thank the many people from whom I have received stimulating and helpful ideas I hope that I may have interested you, too

Practice among Africans is bedevilled by the language difficulty There are 15 or 20 languages spoken in my wards every day I speak 3 'Ndebele Shona and Chinyanja. In 'Ndebele we have a pleasant form of greeting 'Mehlo Mhlope" meaning "I see you with white eyes." No envy malice or thoughts other than friendship

So to all Spectators—"Mehlo Mhlope"

J H. G ROBERTSON

# 26

# Reaction to Nuts in a Wilson Type Fusion

EUGENE G LIPOW, M.D *

Nylon and nylon preparations and prostheses are in increasing use both in quantity and in a larger variety of forms and uses in orthopaedic surgery Reports have been received from various sources of some undesirable reactions to this class of materials There reactions have been classified roughly as "allergic" to nylon or of irritation due to nylon Whether or not nylon as such gives rise to the so-called "allergic" reactions or acts as a foreign-body irritant in tissues is debatable However vascular changes with dilitation of vessels perivascular infiltration changes in surface tension and tissue disintegration have been reported. These changes are followed by a formation of an inflammatory exudate which then are succeeded by a partial process of repair with fibrosis Often the entire change from edema of the tissues to fibrosis is seen with both allergic and foreign-body irritation.

To my knowledge the following case is the first presented in which the locking nylon device incorporated in an elastic stop nut of Vitallium caused an unexpected reaction in a Wilson plate type fusion The nut bolt combination used in holding the Wilson plate to the spinous process has nylon incorporated in the nut to prevent slippage. The material used for the locking washer is surgical nylon from a reputable source This washer is inserted into the cast nut with an extending flange which later is clipped over the nylon. In using, the threaded portion of the bolt gets under way by means of 2 or 3 Vitallium threads out into the nut, and then the bolt has to be turned with some force through the nylon washer which then acts as a collar This collar prevents slippage

A reaction showing irritative phenomena suggestive of either foreign-body and/or allergic irritation was responsible for considerable embarrassment. However this reaction did not prevent solid bony fusion in the usual time

R. H. aged 39 white male mechanic, was first seen on November 22 1952 at which time he stated that some 10 months previously while working in a tunnel he was hit in the back by an outgoing train He was taken to a hospital and was treated conservatively but with little help He was treated subsequently in other hospitals and by other physicians with analgesics various physiotherapy modalities and both rigid and semirigid supports He said that none of these measures gave him relief His backache was increasing in intensity and the acute episodes were becoming more frequent. Marked tenderness was noted at the fourth and the fifth lumbar as well as the first sacral vertebrae Roentgenograms of the lumbosacral spine showed a severe spondylolysis of the fifth lumbar vertebra with anterior displacement of the fifth lumbar on the first sacral vertebra.

A diagnosis was made of an aggravation of this pre-existing condition following the

* Washington D C

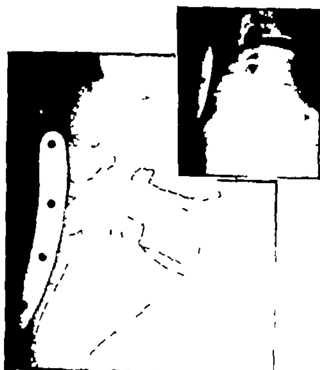


Fig 3 Three months after operation and just prior to removal of the Wilson plate



Fig 4 Fusion progressing well 7 months after removal of nuts and Wilson plate

was a necrotic cystic area surrounded by granulation tissue numerous leukocytes and multinucleated giant cells Areas of calcified material also were present.

Some allergists believe that when contact and scratch tests fail to bring out reactions or are not entirely conclusive with the sus pected allergens the suspected material should be inserted deeply That is to say that the environment in which these aller gens are placed should approximate the tis sues in which these suspected substances are used Therefore the following day washed nylon sutures were inserted in the subcuta neous and deep muscle tissues of the thigh These were open stitches into the subcutaneous fat, just under the fascia lata and deep into the rectus femoris of the thigh Within 24 hours severe pain redness swelling and serous drainage were noted in and round these sutures Unfortunately no cultures were made of this drainage But, upon removal of these sutures the redness and the drainage disappeared within 6 hours, and within 24 hours the previously inflamed area was apparently normal

From the above it appears that the nylon in the nuts, rather than the metallic nuts and the Vitallium plate was responsible for the reaction To repeat, no portion of the plate the bolts or as far as could be determined, the metallic parts of the nuts were involved in the reaction of the tissues in question Only the collar portion containing the nylon was noted in the process

I feel that this particular complication is one that must be considered *before* using nylon fittings or prostheses and strongly urge that before nylon is used in orthopaedic (or other) surgery a sensitivity test, using washed nylon sutures inserted subcutane ously be tried.

## Reactiones al Vites Matre in un Fusion del Typo Wilson

*Summario in Interlingua*


Nylon in uso intrahistic causa alterationes vascular con dilatation del vasos infiltration perivascular cambiamentos del tension superficial e disintegration histic Iste alterationes es sequite per le formation de exsudato inflammatori e per un processo partial de reparation con fibrosis

Es presentate un caso in que nylon esseva usate in le fixation de vites matre de Vitallium in un fusion del typo Wilson Le nylon esseva probabilemente le causa de un reaction irritative que necessitava le elimination del vites matre sed que non preveniva le fusion solide del ossos.

Il se tractava de un caso de sever spondylolyse Un fusion del typo Wilson esseva interprendite con graffos iliac Le platta de Wilson esseva attachate al processos spinose de L-4 L-5 S-1 e S-2 Le curso postoperative esseva routinari usque al 22nde die quando un drainage serose se disveloppava in le incision. Iste drainage se provava negative pro organismos in repetite examines e le fusion progredeva satisfacentemente A causa del continuation del drainage le possibilitate de un reaction al nylon del vite esseva prendite in consideration e le area esseva explorate le 97me die post le operation

Esseva trovate un area de edema con tractos sinose ducente verso le vites matre in le processos spinose de L-5 S-1 e S-2 insimul con texito non-differentiate locos de texito fibrose e hyalinisate e augmentate capillaritate Le fusion esseva solide

Le impression predominante del examine microscopic esseva illo de areas de infiltration perivascular e leucocytic e de areas cystic necrotic con gigante cellulas mononuclear e multinucleate Post le elimination del platta le vulnere se curava normalmente

Pro determinar si o non le reaction esseva causate per nylon suturas de nylon esseva inserite in grassia subcutanee e musculo profunde del coxa Intra 24 horas un dolorose e rubie area de turgiditate con drainage serose se disveloppava circa le suturas Post le elimination del suturas le area de inflammation redeveniva apparentemente normal intra 24 horas

Nos recommenda urgentemente que sensibilitate a nylon es determinate in un maniera del supra-describite typo quandocunque on considera le uso de nylon in chirurgia orthopedic

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